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MYCOLOGIA

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VOL. XLI SEPTEMBER–OCTOBER, 1949 NO. 5

SOME LEAFSPOT FUNGI ON WESTERN GRAMINEAE—IV [1]

RODERICK SPRAGUE [2]

(WITH 1 FIGURE)

A study of additional collections of leafspot fungi on Gramineae, made in the interim since the last paper in this series was published, has disclosed the presence of additional noteworthy species in the mountains and plains of the west.[3] The recent seasons have been exceptionally favorable for the development of leaf fungi on Gramineae in Washington and adjacent areas. The precipitation from Sept. 1, 1947 to May 26, 1948 at Pullman, Wash., was 27.46 inches, compared with the 1893–1944 average of 17.94 inches for the period. The April precipitation was an inch over average and uniformly spaced, while that for May was 4.45 inches compared with an average of 1.47 inches for the month. The result of the prolonged, cool, overcast period with almost unbroken high humidity was an outbreak of leafspots unequaled in a quarter of a century. *Septoria tritici* Rob. in Desm. is an example. This species, which was found in considerable abundance in eastern Washington in June 1948, had not been collected east of the Cascade Mts. since 1915, even though it had been carefully searched for in other years.

[1] Published as Scientific Paper No. 831, Agricultural Experiment Stations, Institute of Agricultural Sciences, State College of Washington, Pullman, Wash.

[2] Pathologist, Tree Fruit Exp. Station, Wenatchee, Wash.

[3] Sprague, R. Some leafspot fungi on western Gramineae—III. Mycologia **40**: 295–313. 1948.

[MYCOLOGIA for July–August (**41**: 357–491) was issued July 26, 1949]

Gloeosporium meinersii sp. nov.

Maculis foliicolis elongatis, 0.5–2.0 × 0.1–0.3 cm., fulvis v. ochraceis, emarginatis v. margine angusto, brunneo, centro ultimo pallido; conidiis numerosis, hyalinis, subphaseoliformibus v. oblongis, guttulatis, 9–12.5 × 3.0–3.8 μ.

Hab. in foliis vivis *Phlei pratensis* L., South Prairie, Pierce Co., Wash. July 8, 1948. Legit. Jack P. Meiners et George W. Fischer. **Typus** est **C.S. 3985.**[4] (Wash. State Coll. Dept. of Plant Pathology Herbarium.)

Spots on leaves elongate, 0.5–2 × 0.1–0.3 cm., pale buff to tawny, emarginate or with a narrow brown border, center of spots finally paler; conidia numerous, hyaline, non-septate, subphaseoliform to oblong, guttulate, 9–12.5 × 3.0–3.8 μ.

This fungus, occurring on living leaves, was compared with the conidial stage of *Phialea temulenta* Prill. and Del., the microspores of *Fusarium nivale* (Fr.) Ces., the conidia of *Gloeosporium bolleyi* Sprague and those of *G. graminum* Rostr. It matches none of these. It appears to be distinct and is worthy of recognition. Meiners found the fungus in his routine examination of collections made by him and G. W. Fischer in a grassy, drained-swamp region near Puyallup, Wash.

In addition to the type specimen I found a similar fungus on *Poa alpina* L. which Meiners, Fischer and I had collected on an exposed slope at 11,700 ft. elevation near Monarch Pass, Colo. (C.S. 17,102). The tawny lesions occupied much of the surface of basal leaves. The spores were hyaline, mostly non-septate, curved, subphaseoliform, 10–14 × 3–4 μ. This appears to be only a variant of *G. meinersii* for which the following name is proposed:

Gloeosporium meinersii var. **alpina** var. nov.

Maculis fulvis, emarginatis, acervulis obscuribus, sporulis curvuli-subphaseoliformibus, aseptatis, hyalinis, 10–14 × 3–4 μ.

Hab. in foliis sub-emortuis, *Poae alpinae* L., prope Monarch Pass, Colo. **Typus** est **C.S. 17,102.** Legit. Meiners, Fischer et Sprague, Aug. 7, 1948.

[4] All C.S. numbers refer to the collection series of the Plant Pathology Department of the State College of Washington.

SPERMOSPORA SUBULATA (Sprague) Sprague. What was formerly believed to be a relatively rare leafspot was found in abundance on *Melica spectabilis* Scribn. at Togwatee Pass, Wyo. It was, at least locally, very destructive, causing a blight of the entire plant. The brown, blasted plants were readily broken off at the ground line, leaving the bulbous culm-base in the soil. Many of the spores in this material were without a distinct, elongated apical appendage. However, some of the spores were typical of the fungus as originally described on *Melica subulata*.[5] The area where the diseased host occurred was a sub-alpine, semi-forested meadow or prairie where the *Melica* grew in open spaces.

Linear, light brown to paler spots on leaves of *Agrostis alba* L., collected by Fischer, Meiners and Sprague at Teton Pass, Wyo. (C.S. 20,123), had spores typical for *S. subulata* except that an obliquely attached basal cilium about $10 \times 0.4\,\mu$ was found on approximately 35 per cent of the spores in one mount. Spores of a second mount from the same collection, however, were virtually devoid of cilia. On referring back through all other available collections we found no cilia in material on *Melica* spp., nor on *Deschampsia caespitosa*, and one or two spores with cilia in material collected on *Calamagrostis*. We cannot find any difference in these various collections except in the occasional presence of cilia in some of them. While this is somewhat startling we are not segregating the two forms, ciliate and aciliate, except to the minor extent of emending the description of *Spermospora* to permit inclusion of the ciliate forms, and to present a formal description of the ciliate group as a morphological form of *S. subulata*.

SPERMOSPORA Sprague emend.

Conidia subulate to subulate-filiform, hyaline, septate, apical cell appearing appendage-like, sometimes with an oblique-basal cilium, borne superficially on evident short conidiophores in spots. A member of the Moniliales and the Moniliaceae.

Spermospora subulata f. **ciliata** f. nov.

Item ut in specie sed basibus sporulis ex obliquo ciliati, hyalini $10 \times 0.4\,\mu$.

[5] Sprague, R. Undescribed species of *Cercosporella* and *Cercospora* on certain grasses in Oregon and Washington. Mycologia **29** (*2*): 199–206. 1937.

Hab. in foliis vivis *Agrostis albae* (**type** C.S. **20,123**), Teton Pass, Wyo. et *Calamagrostis rubescentis*, Andrews Creek, Wash.

Same as species but with some of the spores carrying an obliquely attached basal cilium, $10 \times 0.4\ \mu$.

The collection on *Calamagrostis* was reported recently with spores $50–80 \times 7.0–8.4\ \mu$[6] but illustrated with spores $40–51 \times 4.5–5.0\ \mu$ taken from a second mount. The first measurements were taken from material which had been carried in a fishing basket for several days and apparently some of the spores were abnormally swollen. Probably the measurements $35–50 \times 4.5–5.4\ \mu$, taken from another mount of this material, are closer to the typical condition.

OVULARIA PUSILLA (Ung.) Sacc. and D. Sacc. on *Festuca idahoensis* Elmer. A confusing leaf spot of Idaho fescue found in Idaho Co., Idaho, was eventually determined as being caused by *O. pusilla*. The black to purple-black lesions encircle the filiform or involute leaves and extend along the culm for a distance of 0.5 to 1.5 cm. While the lesions are numerous and relatively prominent, the hyaline conidiophores are difficult to find except on older lesions which have faded to an ashy hue. These older lesions are often bordered by wine-colored tissue. The spots were abundant on Idaho fescue growing along slopes above the South Fork of the Clearwater River, Idaho. This spot has been found on this host elsewhere in the Pacific Northwest but earlier collections were not identified because the fungus was either overlooked or the few spores that were present were not recognized. Very often only a few oval, hyaline spores were found in a mount and sometimes none.[7]

RHYNCHOSPORIUM ORTHOSPORUM Caldwell on *Dactylis glomerata* L. from Kendrick, Ida. (C.S. 17,014) differed from other collections on this host in the presence of 2- to 3-septate spores which were as large as $31 \times 4.0\ \mu$. These spores were otherwise typical and were borne in characteristic white lesions. *R. orthosporum* was common on *Dactylis* in northern Idaho in 1948.

ERYSIPHE GRAMINIS DC. on *Calamagrostis rubescens* Buckl. The conidial stage of this common mildew was found in small

[6] Loc cit., p. 308.

[7] Loc cit.; for a discussion of *O. pusilla* see pp. 309–311 of the 1948 paper.

quantities on leaves of pine grass below Hebgen Dam, Madison River, Mont. (C.S. 17,170). We have no record of mildew on *Calamagrostis* in the western area and this report may be of interest to those studying racial development in the species.

HELMINTHOSPORIUM VAGANS Drechsl. on *Poa bulbosa* L. The leaves, sheaths and vegetatively propagated heads of this grass were severely attacked at Pullman, Wash., during wet weather. This fungus, as usual, was common and destructive on *Poa pratensis*, but bulbous bluegrass has not been found infected with the fungus before. The fungus was identical with *H. vagans*. Probably the unusually wet season was instrumental in permitting attack of *P. bulbosa*, generally considered resistant in the field.

Phyllosticta minutaspora sp. nov.

Foliis dilute aureis, pycnidiis in lineis nigris dispositis, gregariis, substromaticis, pycnidiis minutis, carbonaceis, nigris, ostiolatis, globosis, 40–80 μ diam. Pycnosporulis minutis, hyalinis, bacillaribus, 3–4 × 0.5–0.7 μ.

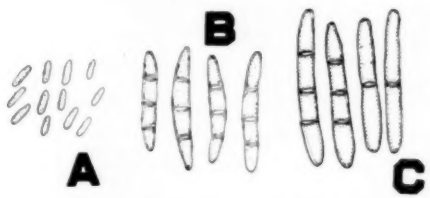


FIG. 1. *A*, pycnospores (microspores) of *Phyllosticta minutaspora* from type; *B*, pycnospores of *Hendersonia culmicola* var. *minor* on *Festuca rubra*, Newport, Oreg.; *C*, pycnospores of *H. culmicola* var. *minor* on *F. idahoensis*, Feather River, Calif. (All × 1,000.)

Hab. in foliis languidis *Muhlenbergiae filiformi* (Thurb.) Rydb. Prope Warm River, Ida. Legit. R. Sprague, Jack P. Meiners, et G. W. Fischer. Aug. 13, 1948. **Typus** est **C.S. 20,033.**

Infected leaves pale yellow, dying, pycnidia in black narrow lines, gregarious, somewhat or thinly surrounded by stromatic tissue, small, black, irregularly ostiolate, carbonaceous, globose, 40–80 μ diam. Pycnospores bacteria-like, hyaline, 3–4 × 0.5–0.7 μ (microspores).

On dying leaves of *Muhlenbergia filiformis* 10 miles north of Warm River, Idaho. Sprague, Meiners and Fischer Coll., C.S. 20,033 (type).

This species appears to be more parasitic than most *Phoma*-like fungi on Gramineae. The lower leaves of current season foliage turn yellow after invasion. The pycnidia are somewhat imbedded in fungus tissue, which gives a black appearance to the lesions. However, this tissue is interrupted and more or less *Phoma*-like. The fungus is related to a number of *Phoma* and *Phyllosticta* spp. with microspores (FIG. 1, *A*) but warrants recognition because of the very small spores. Its parasitic habit distinguishes it from the numerous saprophytic forms which are more or less morphologically similar. It would appear inadvisable to assign this fungus to one of the saprophytic types.

SEPTORIA AVENAE Frank on *Agrostis exarata* Trin. This blotch was collected by Meiners and Fischer in northwest Oregon near Elsie (C.S. 20,035). It showed globose, light brown pycnidia as much as 140 μ diam., containing 3-septate, cylindrical spores 33–39 $\times$ 3.2–3.8 μ.

SEPTORIA CALAMAGROSTIDIS (Lib.) Sacc. on *Agrostis rossae* Vasey was found at 11,000 ft. elevation in the Medicine Bow Natl. For., Wyo. (C.S. 17,037). The pycnidia were found on the lower leaves of this obscure host and contained narrow, curved, filiform spores ranging up to 48 μ long. The fungus is readily assignable to *S. calamagrostidis*.

SEPTORIA JACULELLA Sprague on *Bromus carinatus* Hook. and Arn. was collected at three places near Mesa Lake (Skyway), Colo. This represents a considerable extension of the range of this species.[8] It has now been found from Montana (on *B. ciliatus*) along the Madison River through Wyoming and Colorado south to Arizona and is, of course, abundant in the Pacific Northwest. The material from Colorado carried so many of the prominent black pycnidia that the leaves resembled those covered with the telial stage of a leaf rust. The spores were not as stiffly javelin-like as those from Washington and Oregon but they were accompanied by quantities of the bacteria-like microspores. The macrospores were stiffly curved to straight, 2- to 3-septate, 60–72 $\times$ 2.3–3.4 μ, mostly about 65 $\times$ 3.0 μ.

[8] Sprague, R. Septoria disease of Gramineae in Western United States. Oregon State Monographs, Studies in Botany No. 6. 1944 (Published by the Oregon State College, Corvallis). 151 pp.

SEPTORIA OUDEMANSII Sacc. on *Poa reflexa* Vasey and Scribn. The leaf sheaths of sub-alpine material of this host collected near Mesa Lake, Colo. (C.S. 17,071) carry a number of pycnidia containing spores comparable to those of *S. oudemansii*. The fungus differs somewhat from the common form on lawn grasses. The pycnidia are light colored with small pore-like ostioles which are surrounded by much darker cells than the rest of the cells of the pycnidia. The spores are also narrow for this species, many of them averaging about 17 × 1.6 μ. They range up to 2.5 μ diam., however, and this collection is therefore assigned to *S. oudemansii*. Material on *Poa pratensis* from the same area had spores 16–28 × 2.0–3.0 μ borne in pale, red-bordered spots. This approached *Septoria nodorum*. Material on *P. palustris* L. from Skyway, Colo., had spores 15–21.3 × 2.2–3.0 μ.

SEPTORIA SECALIS var. STIPAE Sprague. Jack Meiners collected this fungus on *Stipa columbiana* var. *nelsonii* (Scribn.) Hitchc. along the South Fork of the Palouse River about seven miles up stream from Colfax, Wash. (C.S. 20,022). It is interesting to note that this variety, first described on *Stipa viridula* in South Dakota,[9] occurs a great distance westward from the type area. The Palouse collection, however, has the same cylindrical, hyaline spores as the type. They average 30–48 × 2.5–3.4 μ, mostly 35–45 × 3 μ. After comparing critically with *S. avenae* and *S. avenae* f. sp. *triticea* T. Johnson, the writer is still satisfied that *S. secalis* is distinct because of its relatively narrower, more bacillar spores. Perhaps our variety is unnecessary but we maintain it for the reasons given at the time it was described.[10] The Palouse River collection is the first report of this fungus from Washington, but we have one collection on *Agrostis hallii* Vasey from Helmick Park, Oregon. The Palouse material is represented by scattered pycnidia in bleached areas and is usually associated with *Scolecotrichum graminis* Fckl.

HENDERSONIA CULMICOLA var. MINOR Sacc. on *Poa*. This fungus is a common saprophyte on dead grass leaves in the western United States. We have collected it many times. Spores of

[9] Sprague, R. Some leaf spot fungi on western Gramineae. Mycologia 33 (6): 655–665. Nov.–Dec. 1941.

[10] Loc. cit.

two collections on *Poa* spp. are, perhaps, somewhat distinct from the narrowly fusiform, 1- to 3-septate yellow spores found on *Festuca* (FIG. 1, *B*) and other hosts. One collection on *Poa gracillima* Vasey from Logan Canyon, Utah, made in 1947 (C.S. 3644), had cylindrical to subfusiform, yellowish, guttulate, 1-septate spores 16.5–19 × 2.2–2.7 μ borne in golden brown pycnidia 50–110 μ diam. Another collection on *P. secunda* Presl, from the South Fork of the Clearwater River, Idaho (C.S. 17,113), had sub-cylindrical spores 16–18 × 2.5–3.4 μ. The spores were guttulate, then finally faintly 1-septate and yellow. These are similar to an earlier collection on *Festuca idahoensis* made along the Feather River in California (FIG. 1, *C*). Both collections had pycnidia which were scarcely ostiolate or tardily so. The material from Idaho gave some indications that the fungus was weakly parasitic as the pycnidia were in bleached to brown spots on dead parts of senescent leaves. The host in the Idaho material was taken from a rocky ledge which had, in recent years apparently, been overgrown with timber. Hence the habitat during this very wet year was abnormally unfavorable for this particular prairie species of *Poa*. We have seen little evidence that *H. culmicola* var. *minor* is actively parasitic. It appears to be a primary invader of dying leaf, culm or sheath tissue.

STAGONOSPORA SIMPLICIOR Sacc. and Berl. This saprophyte was found on basal leaves of *Festuca ovina* var. *brachyphylla* (Schult.) Piper at 10,000 feet elev. near Skyway, Colo. (C.S. 17,069). The lesions were obscure, and the dark brown pycnidia were relatively numerous and scattered or grouped along the filiform leaves. The ostiolate pycnidia were approximately 100 μ in diameter. The spores were mostly 1-septate, coarsely cylindrical, somewhat bent and resembled *Ascochyta utahensis* Sprague when young. Older spores were becoming 3-septate and the contents were coarse and faintly tinted. The spores measured 28–35 × 7.4–10.0 μ and, in this material, are not distinguishable from *St. simplicior*. The species seems to be an early invader of frost-injured tissue but it is scarcely parasitic.

STAGONOSPORA FOLIICOLA (Bres.) Bub. on *Glyceria*. A few prominent buff spots with a strong brown border were collected on *Glyceria elata* (Nash) Hitchc. ten miles north of Glendevey,

Colo., in a marsh (C.S. 17,121) on Aug. 9, 1948, by the writer and Jack P. Meiners. The pycnidia were deeply sunken, finally ostiolate, globose, gold-brown, 113–160 μ, scattered in the spots. The spores were blunt at the base, jointed at the apex and typically curved from being crowded in pycnidia which were none too large for the spores. The spores were hyaline, mostly 7-septate, 66–91 $\times$ 5.3–6.6 μ. The fungus is indistinguishable from *St. foliicola* except for the prominent border of the leaf spot. It is assigned to *St. foliicola* which causes a common spot on an associated marsh grass, *Phalaris arundinacea* L.

STAGONOSPORA VEXATULA Sacc. on *Deschampsia*. An immature pycnidial form on necrotic leaves of *D. caespitosa* (L.) Beauv. was obtained in a ditch near Plummer, Idaho, by the writer and C. Gardner Shaw June 16, 1948 (C.S. 3969). The pycnidia were slightly erumpent in lines in fuscous or stramineous spots, globose, flattened, ostiolate, parenchymatous, golden brown by transmitted light, 110–170 μ diam. The spores were hyaline, 30–40 $\times$ 4.5–5.5 μ, with numerous coarse oil drops and were 3-septate but evidently immature. They were cylindrical but somewhat pointed at the apex and slightly rounded at the base, giving them a slightly fusiform aspect in some cases. These spores seem to answer the description of *St. vexatula* Sacc. which occurs on *Phragmites communis* Trin. The pycnidia are much larger on *Phragmites* but it is believed that the ample food available in the culms and sheaths of *Phragmites* can account for this difference. *St. vexatula* is an early invader in necrotic leaves of the giant reed and it is probably only dubiously parasitic on *Deschampsia*. Since it shows some morphological similarities to the parasitic species *St. foliicola* (Bres.) Bubak it may warrant further observation as it may in some cases prove parasitic under the favorably humid habitat of *Deschampsia*. The harsh wiry leaves of this host are, however, in general, very resistant to invasion by leaf-spotting fungi.

STAGONOSPORA GRAMINELLA Sacc. Saprophytic material on *Agrostis oregonensis* Vasey from woods along the South Fork of the Clearwater River, Idaho, is assigned to this species. The flattened, globose, brown, ostiolate pycnidia are grouped on dead leaves. The nearly cylindrical, hyaline to faintly tinted spores measured 18–22 $\times$ 3–5 μ. The cells contained large guttulae.

This fungus is assigned to *St. graminella* but it was compared critically with *St. insularis* Speg., *St. agrostidis* Syd. and *St. smolandica* Eliasson, all of which occur on *Agrostis* and which have spores approximately the same dimensions as those of *St. graminella*. The comparative morphology of this group is as follows:

Name	Host	Pycnidium		Spore	
		Size, μ	Shape	Size, μ	Shape
St. agrostidis Sydow.	*Agrostis vulgaris*	180–250	globose-depressed	24×4	fusoid, curved to subfalcate
St. graminella Sacc. (Type)	grass	——	globose-papillate	18–20×3–3.5	cylindrical
St. graminella Sacc. (Local)	*Agrostis oregonensis*	80–145	globose-depressed	18–22×3–5	cylindrical
St. insularis Speg.	*Agrostis magellanica*	80–90	lenticular	18–24×3	cylindrical to subclavate
St. smolandica Eliasson	*Agrostis vulgaris*	80–90	globose-depressed	19–22×3	cylindrical

The only species which appear to match the Idaho material are *Stagonospora graminella* and *St. smolandica*. The latter is associated with a *Phyllachora* species and is ruled out in favor of the earlier named *St. graminella*.

STAGONOSPORA BROMI A. L. Sm. and Ramsb. A specimen collected on *Bromus carinatus* (C.S. 20,014) on the South Fork of the Clearwater River, Idaho, differs from other material in the spore dimensions. While most of the spores in this collection are short, 15–20 × 2.7–3.6 μ, some of them are as much as 42 × 4 μ. The spores are hyaline, cylindrical, less often subfusiform. The longer spores are sometimes blunt at the base and narrowed at the apical end. Therefore this collection ranges into *Septoria avenae*, *S. agropyrina*, or even *Stagonospora arenaria*. Under our present knowledge of this group it seems logical to retain *St. bromi* and not assign the fungus to *S. avenae*.

All of the collections of *Stagonospora bromi* have the black or purple-brown leafspots characteristic of the species. Whether this is really a specific character or is related to the reaction of bromes to parasitic fungi is open to question. Certainly most leafspots on bromes are dark brown or black.

BLACK STEM ON GRASSES. A number of collections were made of a black stem disease on various species of grasses in northern and west-central Idaho in 1948. The stem for several inches or sometimes its entire length was black as though it had been burned. In one specimen on *Festuca elatior* L. near Post Falls, Idaho, small subsuperficial black pycnidia were formed and the entire blackened area was invaded by very fine, dark, somewhat superficial mycelium. The pycnidia contained hyaline microspores 4–6 × 0.5 μ diam. These were spermatia-like and some of the pycnidia appeared to contain ascogenous initials. This specimen (C.S. 17,079) is filed in the herbarium of the Dept. of Plant Pathology, W.S.C., under *Phoma* sp. I see no reason for describing this species until detailed work is done with it. The same fungus was found on *Festuca idahoensis* Elmer at 10 miles north of Warm River, Idaho (C.S. 20,051), Targhee Pass, Idaho (C.S. 17,133), and in adjacent Mont. (C.S. 17,133). Probably the same fungus was involved in the same symptoms on *Festuca idahoensis* near Desmet, Idaho and on *F. occidentalis* Hook. near St. Regis, Mont. (C.S. 20,077). Material on *F. idahoensis* at McCall, Idaho (C.S. 20,013), was confined to the leaves which were jet black. No pycnidia were present but small mycelial aggregates up to 30 μ in diameter were scattered among the black mycelia. A few spores of *Cladosporium* sp. were present. Black streaks with numerous erumpent ostiolate pycnidia (30–60 μ) were noted on culms and sheaths of *Agropyron spicatum* (Pursh.) Scribn. and Sm. collected on the South Fork of the Clearwater River, Idaho (C.S. 20,016). The aseptate hyaline spores were bacillus-like, 3.5–5.5 × 0.4–0.6 μ. The writer and colleagues saw these symptoms on a number of other hosts but field examination failed to disclose any organism and frequently the material was discarded without further study. Similar material was collected by C. L. Lefebvre on *Festuca* spp. in Alaska.

The black-stem fungus produces a much more extensive charring than that caused by *Phyllosticta minutaspora*.

SCOLECOTRICHUM GRAMINIS Fckl. Abundant material on *Muhlenbergia filiformis* (Thrub.) Rydb. from McCall, Ida., another unreported host, brings the total number of hosts parasitized by this fungus to 114 species for the western United States, 132

for the entire country and about 160 species for the world. In recent collections as in earlier ones, this fungus is one of the most abundant and widespread species which we have dealt with. The fungus was common in the mountains of Colorado and Wyoming on *Bromus ciliatus* L., *B. frondosus* (Shear) Wootn. and Standl., *B. purgans* L., *Phleum alpinum* L., and a number of the well known hosts including *Agropyron, Elymus* and *Poa* spp. The fungus was exceptionally destructive on *Melica subulata* (Griseb.) Scribn. and *Bromus carinatus* Hook. and Arn., among others, in the Umatilla Natl. For., Wash., during June 1948 following prolonged rains. *Stipa lemmonii*, in the same area, was nearly killed by the leafstreak fungus. While there is considerable variation in size, especially length of spores, of this fungus on the different hosts, all of the collections are readily assignable to the fungus which we call *S. graminis*.

I am indebted to my colleagues, C. Gardner Shaw, Jack P. Meiners, and George W. Fischer, for aid in collecting specimens discussed in this paper.

NEW MONOCENTRIC EUCARPIC OPERCULATE CHYTRIDS FROM MARYLAND[1]

JOHN S. KARLING

(WITH 78 FIGURES)

In addition to the polycentric chytrids previously reported by the author (**1949**) from Maryland, a large number of monocentric eucarpic species were collected and isolated from soil and water. Among these were six new endo- and exoöperculate species which are characterized by large sporangia with one to several exit papillae or tubes and coarse, richly-branched rhizoids which usually arise at several points on the periphery of the sporangium. Accordingly, they apparently belong in the genus *Karlingia* which includes *Rhizophlyctis*-like chytrids with operculate sporangia.

This genus was established by Miss Johanson (**1944**) for the long known and commonly occurring chytrid, *Rhizophlyctis rosea*, which she found to be endoöperculate. She, accordingly, removed it from *Rhizophlyctis* and renamed it *K. rosea*. Since that time the concepts of the genus have been extended to include exoöperculate species as well (Karling, **1947**). At present it includes four species, all of which were isolated and grown on cellulosic substrata and whose occurrence in nature appears to be limited to such natural media. Four of the Maryland species, on the other hand, were isolated on chitin and are distinctly chitinophilic. The other two new species from Maryland were isolated and grown on onion skin, grass leaves and cellophane, and could not be transferred to chitin.

All of these species differ in several respects from the known members of *Karlingia*, as will become evident in the diagnoses

[1] This study was begun at the Chesapeake Biological Laboratory, Solomons, Md., where the author was guest investigator during the spring and early summer of 1948. The writer is indebted to the Department of Research and Education, State of Maryland, and particularly to the Director of the Laboratory, Dr. R. V. Truitt, for providing research facilities and funds for this work.

which follow. They are, accordingly, regarded as new species and named *K. chitinophila, K. asterocysta, K. curvispinosa, K. dubia, K. lobata,* and *K. marylandia.*

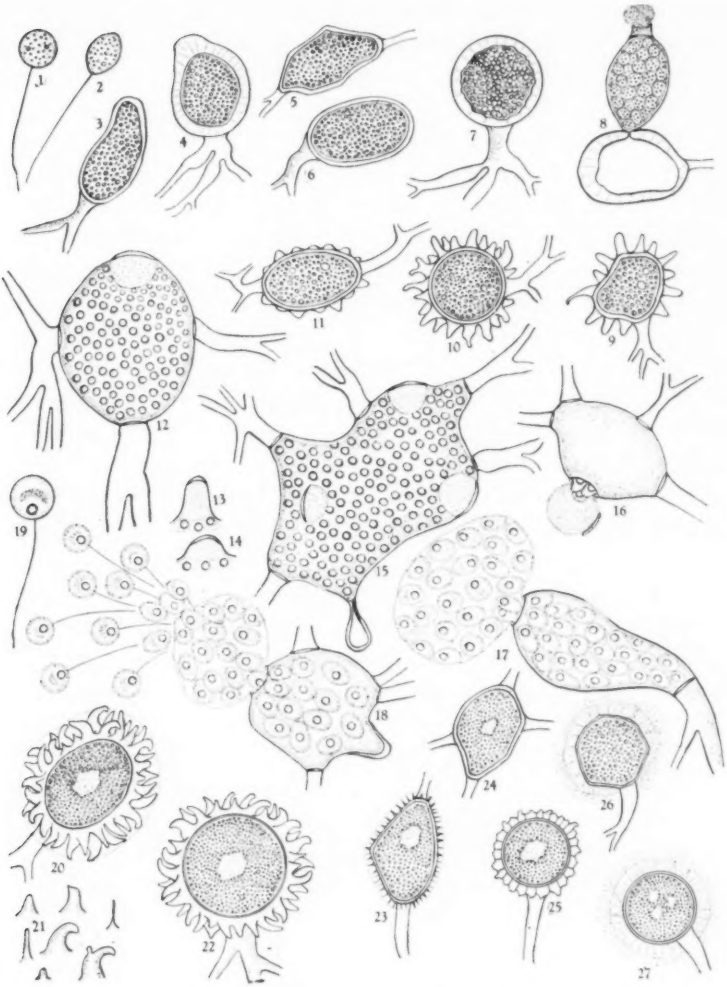
In all of these species the sporangia and resting spores usually develop directly from the zoospore as has been described for the other members of the genus. However, in a low percentage of the thalli they may develop from a local enlargement of the germ tube, and in such cases the zoospore cyst may become thick-walled and persist as an appendage to the sporangium or resting spore. Also, rare polycentric thalli may occur in all species, as has already been reported for *K. granulata, K. hyalina* and *K. rosea* (Karling, **1947**). Furthermore, in most thalli of the Maryland species numerous rhizoids are present and arise at several points on the periphery of the sporangium, but it is not uncommon to find sporangia with only one or two basal rhizoids.

Karlingia chitinophila sp. nov. (FIGS. 1–8)

Fungus saprophyticus. Sporangiis plerumque totaliter extramatricalibus, hyalinis, laevibus, sphaericis, 10–215 μ, ovalibus, 15–30 × 20–45 μ, pyriformibus, 32–50 × 60–100 μ, citriformibus, elongatis, vel angularis aut irregularibus, 1–26 papillis exeuntibus vel tubulis, 12–70 μ longitudine × 5–8 μ diametro ab infirmo, quarum fines impletae sunt obturamento hyalino glutinoso, quod usque at 5–15 μ supra verticem terminari potest. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis, diametrum, attingentibus 20 μ, maxime ramosis et extensis. Operculo hyalino, tenui, submerso in papillis exeuntibus vel tubulis, vadoso, figura ad modum patellae vel crateris usque ad 12 μ diametro, expulso et ablato, zoosporis emergentibus, aliquibus-operculis accessoriis desorptis in sporangia, zoosporis emergentibus et pressione interna relaxante. Zoosporis hyalinis, sphaericis, 3.18–3.71 μ, plurimis granulis minutis praestantibus, flagello 22–24 μ longitudine. Sporis perdurantibus levibus, sphaericis, 8–26 μ, ovalibus, 8–18 × 11–23 μ, oblongatis, angularibus vel irregularibus, pariete crasso praeditis, 2–6.3 μ diam., colore olivaceo, rebus contentis crasse granulosis. Germinatione a prosporangio.

Saprophytic on chitinous substrata in soil and water, Frederick and Keesville, Md.

As is evident from the above diagnosis, this species is almost the hyaline chitinophilic counterpart of *K. rosea.* Therefore, it need not be illustrated extensively for adequate description, and the accompanying drawings (FIGS. 1–8) are limited to the zoospores and resting spores. Except for its hyaline color, smaller



FIGS. 1–27. Species of *Karlingia*.

zoospores (FIGS. 1, 2), and liking for chitin it is identical to and might readily be mistaken for unpigmented specimens of *K. rosea*. However, when it is studied intensively distinctive differences become apparent. The zoospores are from 1 to 2 μ smaller in diameter, more nearly spherical while swimming, and have a

shorter flagellum. Also, the included granules are hyaline instead of faintly rose or pink colored. As a result the protoplasm in the sporangia is always hyaline to greyish granular in appearance. Thalli have been grown under a wide variety of temperature and light conditions, but the sporangia never varied in pigmentation, as often occurs in *K. rosea* under such conditions.

Another striking difference is the inability of *K. chitinophila* to grow on cellulosic substrata. Numerous attempts have been made to grow it on cellophane, onion skin, bleached grass segments, filter paper, cotton fibers, etc., without success. It has a distinct liking for purified chitin, and bits of this material may become completely overgrown in a few days. However, this species is not completely limited to growth on this type of substratum, but like many other chitinophilic species it may grow to a limited extent on dead keratinized tissues such as skin and hair.

The resting spores also differ somewhat from those of *K. rosea* and the other known members of the genus. They vary markedly in size and shape (FIGS. 3–8) and are greenish-brown in color. The wall may become exceptionally thick (FIGS. 4, 7, 8), and within it may occur faint radial lines or striations. Also, the inner periphery of the thick wall often appears to be irregular (FIG. 7). The resting spores developed very abundantly in the collections from Keesville and Frederick, Md. However, in a culture isolated from moist soil from Liberia, Africa,[2] no resting spores have developed in the course of fourteen months. Whether or not heterothallic strains occur in this species, as Couch (**1939**) reported for *K. rosea,* is not known, since no attempts have been made to cross the Liberian culture with the ones from Maryland.

The sporangia of *K. chitinophila* show the same degree of variation in size, number of exit papillae, position and number of rhizoids as those of *K. rosea, K. spinosa,* and *K. hyalina.* The small and medium-sized sporangia at the edges of the substratum, however, often develop long exit tubes instead of papillae. These tubes taper gradually towards the apex and may vary from 12 to 70 μ in length by 5 to 8 μ in diameter. During the late stages of development the tips of the exit papillae and tubes deliquesce,

[2] I am indebted to Dr. J. T. Baldwin, College of William and Mary, Williamsburg, Va., for this and numerous other soil collections from Liberia.

after which plugs of hyaline material become visible in the orifices (FIG. 8). At the same time endoöpercula form beneath the plugs at varying depths in the papillae and tubes. Apparently, by this time cleavage of the protoplasm into zoospore initials has occurred because the sporangia appear to be filled with fairly well-defined segments. This phase, similar to that shown in figure 8, may persist from several hours to more than a day before dehiscence occurs. Similar persistence of what appears to be a post-cleavage phase has been observed in *K. asterocysta, K. curvispinosa* and *K. dubia,* and this seems to be a fairly distinct characteristic of these chitinophilic species.

During dehiscence the operculum is pushed up and out by the emerging mass of zoospores in the same manner described by Miss Johanson (**1944**) and the author (**1947**) for *K. rosea* and *K. hyalina.* This usually occurs so quickly that the operculum may be completely overlooked unless it is under direct observation at the moment of dehiscence.

Karlingia asterocysta sp. nov. (FIGS. 9–19)

Fungus saprophyticus. Sporangiis hyalinis, laevibus, sphaericis, 20–110 μ, ovalibus, 15–30 × 28–45 μ, pyriformibus, 12–40 × 29–75 μ, oblongatis, elongatis, fusiformibus, vel angularibus; 1–4 papillis exeuntibus, 8–14 μ diam. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis diametrum attingentibus 18 μ maxime ramosis et extensis. Operculo hyalino, vadoso, figura ad modum patellae vel crateris usque ad 14 μ diam. Zoosporis hyalinis, sphaericis, 4.2–4.6 μ, cum uno globulo refractivo hyalino, 0.7–1.2 μ diam., flagello 24–26 μ longo. Sporis perdurantibus sub sphaericis, 15–30 μ, ovalibus, 12–16 × 14–22 μ, oblongatis, angularibus vel irregularibus, spinosis vel verrucosis, colore olivaceofulvosis, contentis granulosis. Germinatione ignota.

Saprophytic on chitinous substrata in soil and water along routes 232 and 234, Charles County, Md.

This species, as noted above, is characterized primarily by large exoöperculate sporangia (FIGS. 12, 15) and somewhat stellate or asteroid resting spores. The latter are slightly similar to the resting spores of *K. spinosa* but otherwise the two species differ in several respects. *Karlingia asterocysta* lacks the golden-orange pigmentation of the former species, has slightly larger zoospores and exo- instead of endoöperculate sporangia, and a distinct predilection for chitin.

Resting spores occur very abundantly in this species, and in most subcultures studied they developed before and in greater numbers than the zoosporangia. As shown in figures 9 to 11 they are characterized by the presence of blunt to sharp-pointed, tapering, conical pegs which vary from 22 to 60 in number per spore and are 4 to 8 μ high by 2 to 4 μ broad at the base. Occasionally, the tips of the pegs may be slightly curved (FIG. 10). In two spores observed the pegs were reduced to warts with the result that the outer wall was only verrucose. At maturity the pegs and inner wall are usually dark greenish-brown in color, while the content of the spore is hyaline and finely granular (FIGS. 9–11).

In addition to its characteristic resting spores, *K. asterocysta* may be distinguished usually from the other chitinophilic species by its low, inconspicuous and barely perceptible exit papillae, which seldom project much above the surface of the sporangium (FIGS. 12, 15). Nevertheless, their position can be readily detected by the presence of a large hemispherical area of hyaline matrix underneath. In large sporangia these areas may be as much as 15 μ across and extend to a depth of 16 μ in the sporangium. It must be noted, however, that in small sporangia the exit papillae may become fairly conspicuous and up to 11 μ high (FIGS. 13, 14). Therefore, the size of the exit papillae is not always a reliable diagnostic character.

Another distinguishing characteristic of this species is the swarming of the zoospores for a brief period in a vesicle outside of the sporangium. So far, this has not been observed in the other chitinophilic species. During dehiscence the operculum is pushed up and the slimy matrix exudes first to form a globular mass at the exit orifice (FIG. 16). The emerging zoospores push up into this mass and expand it, until it finally forms only a thin layer around the zoospores as in species of *Chytriomyces* (Karling, **1947**B), *Asterophlyctis* (Antikajian, **1949**), and other chytrid genera. Within a few seconds to 1.5 minutes the zoospores begin to jerk and move about in the mass, and shortly thereafter they start swarming actively in a confined and localized area. This area is bounded by a hyaline, thin, vesicular membrane, which apparently originated from the matrix surrounding the emerging

zoospores (FIG. 17). They swarm in this vesicle briefly for 50 to 80 seconds, after which it ruptures and the zoospores escape (FIG. 18). In the case of large sporangia, however, the vesicle may rupture before most of the zoospores have been discharged, and its presence, accordingly, is of brief duration.

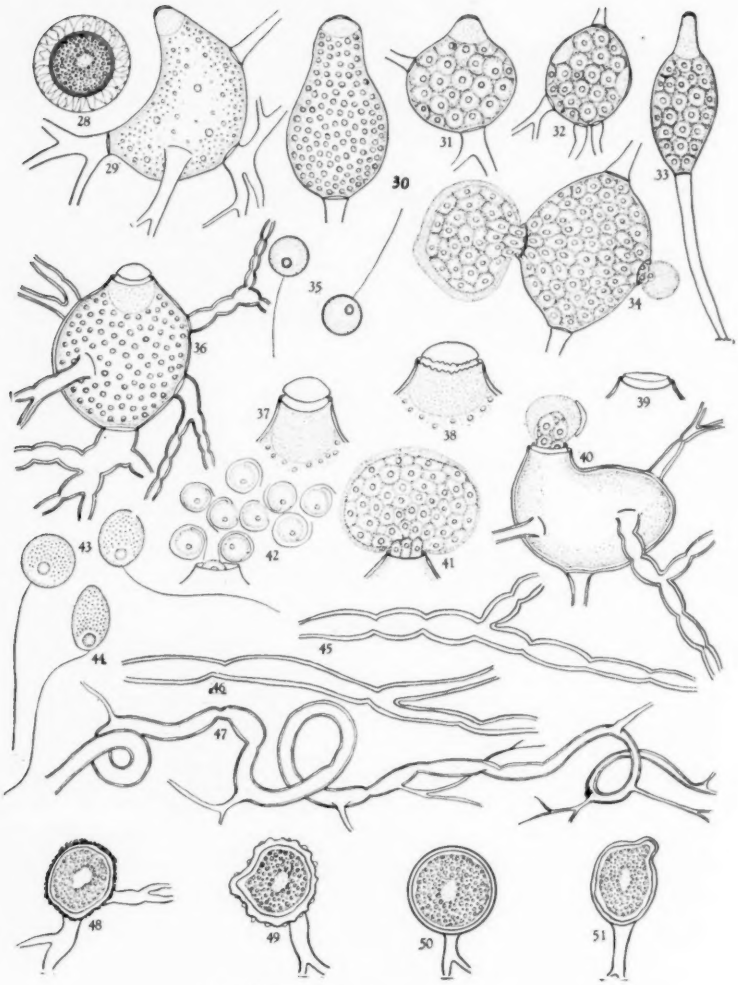
Karlingia curvispinosa sp. nov. (FIGS. 20–35)

Fungus saprophyticus. Sporangiis hyalinis, laevibus, sub-sphaericis, 10–120 μ, ovalibus, 10–80 × 15–140 μ, pyriformibus, 8–70 × 18–160 μ, obclavatis, oblongatis, aut elongatis; 1–3 papillis exeuntibus. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis diametro attingentibus 16 μ, maxime ramosis et extensis. Operculo apiculato in papillis exeuntibus, 6–18 μ diametro. Zoosporis hyalinis sphaericis, 3.8–4.2 μ, cum uno globulo refractivo hyalino, 0.6–0.8 μ diam.; flagello 10–13 μ longo. Sporis perdurantibus sphaericis, 6–21 μ, ovalibus, 8–12 × 11–16 μ, minime angularibus et irregularibus, spinosis vel verrucosis, rebus contentis granulosis; germinatione a prosporangio.

Saprophytic on chitinous substrata in soil and water from a ravine near the Monocacy River at Frederick, Md.

This species resembles *K. asterocysta* in having asteroid resting spores, but the pegs or spines are usually curved and somewhat hook-like and more numerous. In addition, the zoospores are markedly smaller and have a shorter flagellum than those of the previous species. Furthermore, they do not swarm in a vesicle outside of the sporangium. *K. curvispinosa* is also more prolific in growth, and bits of purified chitin usually become completely overgrown with sporangia and resting spores in the course of two weeks. Also, it develops unusually fast and may produce mature sporangia and resting spores in two days. The resting spores develop as abundantly and rapidly as the sporangia, and because of their color the chitinous substratum becomes greenish-amber in appearance within a few days.

Unlike the other known species of the genus, the young incipient resting spores are surrounded by a relatively clear zone of amorphous material in which faint radial lines or striations occur. The pegs or spines gradually develop in this layer as the spores mature and appear to be formed from its material (FIGS. 26–28) in much the same manner as Butler (**1905**) and McLarty (**1942**) described for *Olpidiopsis*. Even in mature spores the



FIGS. 28–51. Species of *Karlingia*.

outer boundary of the layer may sometimes persist, so that the spores appear to lie in a faintly-visible, delicate vesicle (FIGS. 20, 23). In longitudinal view the pegs appear to be pyramidal in shape, usually blunt and abruptly tapered, 4–7 μ high by 3–5 μ broad at the base, and curved or hooked at the tip (FIGS. 20–22).

Sometimes they may be so numerous and closely packed together that they appear to be fused and to form a radially striated outer wall (FIG. 25). Occasionally, the pegs may be reduced to low warts, so that the spores are distinctly verrucose. In rare cases the spores may be echinulate (FIG. 23) or even smooth (FIG. 24). Their content is evenly granular with a small irregular central vacuole, and at maturity the outer wall and pegs are dark-amber or brown in color. During germination they function as prosporangia and form superficial thin-walled zoosporangia. During this process and for several weeks afterwards the pegs persist as fairly rigid structures.

The sporangia vary markedly in size and shape (FIGS. 29–34) as in the previous species and have from 1 to 3 exit papillae which may be low and inconspicuous or somewhat cone- or dome-shaped and prominent (FIGS. 29–33). During dehiscence the operculum is pushed off, and disappears quickly so that its presence can be determined only at the moment of dehiscence. Sometimes the sporangia may be stalked (FIG. 33) and stand off from the substratum to a distance of 25 to 60 μ. Occasionally, ingrowing plugs of wall material occur in the sporangia as in species of *Chytriomyces* (Karling, **1947**).

Karlingia dubia sp. nov. (FIGS. 36–51)

Fungus saprophyticus. Sporangiis laevibus, hyalinis, sub-sphaericis, 20–240 μ, ovalibus, 45–65 $\times$ 60–75 μ, pyriformibus, 15–35 $\times$ 40–78 μ, vel oblongatis, 1–4 papillis exeuntibus, 12–34 μ diam. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis diametro attingentibus 12 μ, maxime ramosis et extensis. Operculo apiculato, vadoso, figura ad modum patellae vel crateris usque ad 10–30 μ diametro. Zoosporis hyalinis, sphaericis, 6–6.5 μ, cum uno globulo refractivo hyalino, 2–2.3 μ diam.; flagello 32–35 μ longitudine. Sporis perdurantibus laevibus vel rugosis et verrucosis, fuscis, sphaericis, 8–20 μ, ovalibus, 9–14 $\times$ 12–17 μ, minime elongatis aut angularibus, rebus contentis granulosis. Germinatione ignota.

Saprophytic on chitinous substrata in soil and water, route 504, Calvert County, Md.

The primary characteristics which distinguish this species are its large exoöpercula and zoospores, and smooth to rugose or verrucose, brown resting spores. Its zoospores are considerably

larger than those of the previously described species, and the operculum has an unusual relation to the sporangium. At maturity it appears to be pushed up and separated from the sporangium wall and to rest on a hyaline, broadly conical cushion (FIGS. 36–38). Its appearance and position relative to the sporangium at this stage is somewhat similar to that in germinating resting sporangia of *Physoderma zeae-maydis* (Tisdale, **1919**). Sometimes, the distance between the lower edge of the operculum and the exit orifice may be as much as 3 to 5 μ, and the line of separation between the two structures may be jagged as well as smooth and even (FIGS. 37–39). When opercula and empty sporangia are examined under the oil immersion lens, however, an inner vesicular membrane or wall becomes visible, which projects out of the exit orifice for a short distance. This is particularly evident in surface and side views of the exit orifice, as shown in figure 39. Apparently, it is this inner vesicle or sporangium wall which grows out into the exit orifice and pushes the operculum up. However, it is not certain that this vesicular membrane is the inner layer of the sporangium wall as suggested in figures 36–40. On the other hand, it may be the wall of an endosporangium of the type present in the germinating resting sporangia of *Physoderma zeae-maydis*.

Underneath the raised operculum is an almost hemispherical area of hyaline matrix which may be 12 μ across and extend to a depth of 16 μ in the sporangium (FIGS. 36–38). This material escapes first as the sporangium dehisces and forms a large globule at the exit orifice (FIG. 40). The emerging zoospores slowly push up into this globule and expand it. At first the expanding mass of zoospores and surrounding matrix is almost spherical, but it soon becomes flattened at the base or even slightly invaginated (FIG. 41) as more zoospores push up into it. In a short while the zoospores begin to separate, and at this stage the flagellum is coiled around the body of the spore (FIG. 42). The flagellum soon uncoils and begins to beat, and within one to two minutes after emerging the zoospores swim away. The swimming zoospore is spherical in shape (FIG. 43) with a conspicuous hyaline refractive globule which usually lies near the base. If zoospores are trapped in a narrow space they may elongate, and in such

instances the refractive globule appears to lie in a vacuole (FIG. 44). In old sporangia cleavage may be very irregular so that large spherical, 8–20 μ, zoospores are formed which contain several refractive globules and have two to eight flagella.

Another noteworthy character of *K. dubia* is the thick-walled and irregularly constricted rhizoids (FIGS. 36, 40, 45, 46). This is particularly distinctive of old and large thalli. In this respect the rhizoids are somewhat similar to those of *K. granulata,* with the exception that the thickening is fairly uniform and may extend almost completely across the lumen of the rhizoid in the constricted regions. Constricted rhizoids, however, are not universal in this species, and in numerous thalli they may be fairly straight with few or no constrictions.

As noted in the diagnosis above, the resting spores are usually smooth (FIGS. 50, 51), but encrusted (FIG. 48), and slightly verrucose spores (FIG. 49) occur fairly commonly. Their content is coarsely but evenly granular with a central, slightly angular vacuole, and the wall is dark brown in color. So far germination of the resting spores has not been observed.

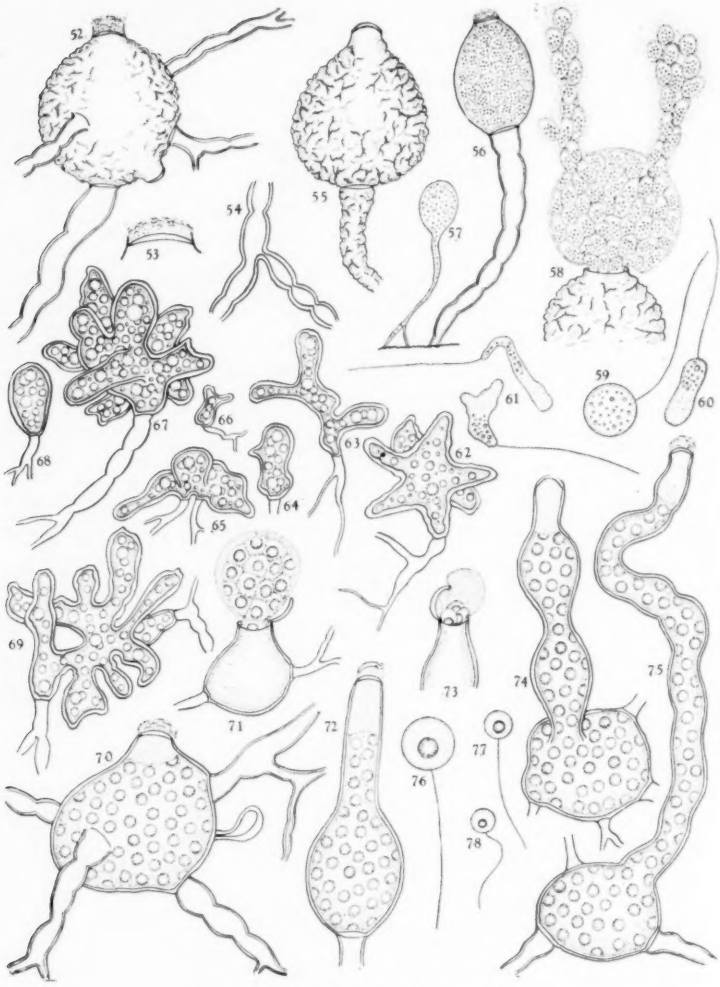
The other two new species, *K. lobata* and *K. Marylandia,* differ from the preceding ones in that they will not grow on chitinous substrata. So far they have been cultured only on onion skin, grass leaves, cellophane, and to a limited extent on dead human skin.

Karlingia lobata sp. nov. (FIGS. 52–69)

Sporangiis hyalinis, sphaericis, 15–180 μ, pyriformibus, 12–40 × 20–160 μ, ovalibus, 9–80 × 14–98 μ, oblongatis, elongatis vel irregularibus 1–4 papillis exeuntibus. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis diametro attingentibus 28 μ, maxime ramosis et extensis. Operculo hyalino, apiculato vel submerso in papillis exeuntibus, vadoso, figura ad modum patellae vel crateris usque ad 20 μ diametro. Zoosporis hyalinis, sphaericis, 5.2–6.1 μ, plurimis granulis minutis praestantibus, flagello 30–32 μ longo. Sporis perdurantibus hyalinis, laevibus, lobatis, irregularibus, angularibus, 7–38 μ diam., germinatione a prosporangio.

Saprophytic on cellulosic substrata in soil and water, route 504, Calvert County, Md.

This species is very similar to *K. granulata* by its endo- and exoöperculate sporangia, irregularly constricted, thick-walled rhi-



FIGS. 52–78. Species of *Karlingia*.

zoids, and zoospores which include from 8 to 20 hyaline refractive granules. In fact the similarity is so striking that until the resting spores were found it was identified as *K. granulata*. In view of this, extensive illustration of this species is not necessary for an adequate description of it and only the most striking differences will be drawn.

Instead of being spherical to oval in shape and brown in color as in *K. granulata,* the resting spores are hyaline, smooth and usually deeply-lobed or irregular in shape and contain numerous small hyaline refractive globules (FIGS. 62–69). In shape they resemble the resting spores of the polycentric chytrid, *Septochytrium plurilobulum* (Johanson, **1943**). A few small oblong and only slightly irregular spores (FIGS. 64, 66, 68) have been found, but they appear to be exceptional. All spores begin as globular enlargements of the germinated zoospores, but the subsequent growth and enlargement is not uniform. As a result numerous protuberances and lobes develop, and eventually the irregular and deeply-lobed spores are formed. After maturity they germinate in the typical chytrid manner by forming a thin-walled zoosporangium.

Another characteristic which distinguishes the large and old sporangia of this species is the structure of their wall. It usually becomes quite thick and wrinkled or ridged, so that such sporangia have a distinctive appearance (FIGS. 52, 55, 58). Sometimes the wrinkling may extend to the basal portion of the rhizoids as well (FIG. 55). As noted earlier, the rhizoids are usually irregularly constricted (FIG. 54), fairly thick-walled, coil extensively in the surrounding water, and may extend for a distance of 1,500 μ. In exceptional monorhizoidal thalli, the main axis may be up to 28 μ in diameter.

The zoospores (FIGS. 59–61) are approximately the same size as those of *K. granulata* and usually vary from 5.2 to 6.2 μ in diameter. However, smaller, 3.9–4.2 μ, and larger, 6.5–7 μ, ones may be formed, but these appear to be abnormal. The refractive granules vary considerably in number and size, and some of them may be distinctly globular and up to 0.4 μ in diameter. While swimming the zoospores are spherical, but when they come to rest and creep about intermittently they become elongate and amoeboid (FIG. 61). The anterior end becomes lobose and relatively clear (FIGS. 60, 61), while the posterior end contains the granules. The zoospores germinate readily in water, particularly in the vicinity of the onion skin, and give rise to free growing thalli of which only the tips of the rhizoids penetrate the substratum (FIGS. 56, 57). Such thalli may develop zoosporangia or resting spores, and

it is not uncommon to find them intermingled at the edge of the substratum.

The formation of endoöpercula is fundamentally the same as in *K. granulata* (FIG. 53) and need not be described further. Both exo- and endoöpercula may occur on the same sporangium (FIG. 52). During dehiscence the operculum is pushed up by the zoospores and may remain attached at one side of the exit orifice or is carried away. Normally, the first discharged zoospores form a globular mass at the orifice and then disperse in a short time while the remainder of them ooze out slowly. Fairly often, however, the initial globular mass is surrounded by a layer of dense matrix and may become quite large in diameter as more zoospores are discharged into it. In such cases the mass may suddenly rupture in localized regions, and the zoospores then stream out in long strands or tendrils (FIG. 58). The spores appear to be stuck together, and from 2 to 4 minutes may elapse before they separate and swim away. In other atypical cases the initial globular mass may not form, and the zoospores ooze out in long sticky strands.

Karlingia marylandia sp. nov. (FIGS. 70–78)

Fungus saprophyticus. Sporangiis laevibus, sphaericis, 20–60 μ, ovalibus, 20–72 × 30–85 μ, pyriformibus, 20–28 × 40–60 μ, oblongatis, elongatis vel irregularibus; 1–2 papillis exeuntibus vel tubulis, 10–26 × 15–204 μ. Rhizoidibus plerumque a pluribus locis in sporangiorum superficie emergentibus, principibus axibus plerumque crassis diametro attingentibus 12 μ, maxime ramosis et extensis. Operculo apiculato vel submerso in papillis exeuntibus vel tubulis, vadoso, figura ad modum patellae vel crateris usque ad 17 μ diametro. Zoosporis hyalinis, sphaericis, 5.5–6 μ, cum uno globulo refractivo hyalino, 2.3–2.8 diametro. Sporis perdurantibus ignotis.

Saprophytic in cellulosic substrata in soil and water from a ditch on the G. A. Stonesifer farm near Frederick, Md.

As is indicated in the above diagnosis, this species is similar to *K. granulata* and *K. lobata* in having endo- and exoöperculate sporangia and irregularly constricted rhizoids (FIG. 70), but it differs from them by the presence of a large hyaline refractive globule instead of numerous minute granules in the zoospores (FIGS. 76–78). In this respect its zoospores are similar to those of *K. hyalina*, but differ by their larger size. *Karlingia marylandia* differs

further from this species by having only 1 or 2 exit papillae and by the lack of conspicuous plugs of hyaline material in them. Furthermore, instead of papillae it may occasionally form exit tubes which may be 10 to 15 μ broad by 26 to 204 μ long (FIGS. 74, 75). Also, the sporangium wall is usually quite thick, 1.8–2.6 μ, in *K. marylandia* and turns brown in old cultures.

The development of endoöpercula in this species is fundamentally the same as in *K. granulata* and *K. lobata*, and they are never deep-seated in the exit papillae or tubes (FIGS. 70, 75). Nor are they developed as commonly as the exoöpercula. The latter are usually deeply bowl-shaped (FIGS. 71, 73), thick-walled, and may persist or be carried away by the discharging zoospores. In a few exceptional sporangia both exo- and endoöpercula were found at and in the same exit papilla (FIG. 72). In such cases an exoöperculum had apparently been formed and pushed up slightly without the subsequent discharge of protoplasm or zoospores, after which an endoöperculum developed lower down in the exit papilla, as reported previously for *K. granulata*.

Dehiscence of the sporangium and discharge of the zoospores usually takes place very slowly so that several minutes may elapse before the sporangium is emptied. As in the previously described species the emerging zoospores form a globular mass at the exit orifice which is at first surrounded by a thick layer of slimy matrix (FIG. 71). The latter expands and becomes progressively thinner as more zoospores emerge and finally disperses in the surrounding water without forming a vesicle. Most of the zoospores are from 5.5 to 6 μ in diameter (FIG. 76), but numerous smaller ones may develop in the same sporangium with the larger spores. These vary from 2 to 3.5 μ in diameter (FIGS. 77, 78) and have a correspondingly short, 18–20 μ, flagellum. Such zoospores degenerate in a short time without becoming actively motile.

Besides the six new species described above, *K. rosea*, the type species of the genus, was isolated from more than thirty soil collections from various parts of Maryland.

With the addition of these new members, *Karlingia* now includes ten species, four of which, *K. rosea*, *K. spinosa*, *K. hyalina*, and *K. chitinophila*, are strictly endoöperculate. Of the remaining six species *K. asterocysta*, *K. curvispinosa* and *K. dubia* are strictly

exoöperculate, while *K. granulata*, *K. lobata* and *K. marylandia* are both exo- and endoöperculate.

According to present interpretations, *Karlingia* is very similar and almost identical to *Rhizophlyctis* in general appearance, structure and development. The only fundamental difference is its operculate sporangia, which is a valid generic distinction. In *Karlingia* most of the sporangia and resting spores develop directly from the encysted zoospore, but in a low percentage of thalli they may develop as an enlargement of the germ tube. In the majority of thalli several rhizoidal axes are present, and these usually arise at several points on the periphery of the sporangium or resting spore. However, thalli with only two or even one rhizoid attached at or near the base occur fairly often. In *Rhizophlyctis*, on the other hand, development of the sporangia and resting spores as an enlargement of the germ tube has not been reported, but when these species have been studied intensively this type of development will probably be found to occur. Furthermore, thalli with a single rhizoidal axis have not been reported in *Rhizophlyctis*.

Thalli of exoöperculate *Karlingia* species with a single basal rhizoid are very similar to those of non-apophysate members of *Chytriomyces* (Karling, **1945**, **1947**), another genus of exoöperculate, monocentric, eucarpic chytrids with extra-matrical sporangia and resting spores, and the same fundamental type of development. The basic differences between the two genera at present are the number and position of the rhizoidal axes and the presence or absence of an apophysis. *Rhizophlyctis* is closely related to an inoperculate genus, *Rhizidium*, and differs from it only by the presence of several instead of a single rhizoidal axis. Obviously, the distinctions between many of the chytrid genera at present are not very sharp, and are often based on slight vegetative structural differences such as those noted above. When these genera are better known, several of them will doubtless be merged. Until that time the exact taxonomic position and relation of *Karlingia* to other similar operculate genera will remain uncertain.

SUMMARY

Six new species of *Karlingia* were isolated from soil and water from various parts of Maryland in 1948. Four of these species,

K. chitinophila, K. asterocysta, K. curvispinosa, and *K. dubia,* were isolated and grown on chitinous substrata and are chitinophilic. The other two species, *K. lobata* and *K. marylandia,* however, are non-chitinophilic and have been grown only on cellulosic substrata such as onion skin, grass leaves and cellophane. *Karlingia chitinophila* is strictly endoöperculate, while *K. asterocysta, K. curvispinosa,* and *K. dubia* are exoöperculate. On the other hand, *K. lobata* and *K. marylandia* are both exo- and endoöperculate.

All of these species have the characteristic type of development and thallus structure of other species of *Karlingia,* and differ specifically by differences in size of zoospores and character of the resting spores.

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EXPLANATION OF FIGURES

FIGS. 1–8, *Karlingia chitinophila.* FIGS. 1, 2, spherical and oval zoospores with numerous minute, hyaline granules. FIGS. 4–7, variations in size and shape of resting spores, and the character of the wall. FIG. 8, germination of resting spore.

FIGS. 9–19, *K. asterocysta.* FIGS. 9–11, asteroid and verrucose resting spores. FIGS. 12, 15, polyrhizoidal sporangia with low inconspicuous exit papillae. FIGS. 13, 14, exit papillae of small sporangia. FIG. 16, initial stage of dehiscence. FIG. 17, zoospores swarming in a vesicle. FIG. 18, rupture of vesicle and escape of zoospores. FIG. 19, swimming zoospore.

FIGS. 20–35, *K. curvispinosa.* FIG. 20, spiny resting spore with a faintly visible, delicate boundary. FIG. 21, variations in size and shape of pegs and spines on resting spores. FIG. 22, large spherical resting spore with curved pegs or spines. FIGS. 22, 23, echinulate and smooth resting spores. FIG. 25, spherical resting spore with closely crowded or fused pegs. FIGS. 26, 27, 28, stages in the formation of the pegs or spines on the resting spores. FIGS. 29–33, variations in size and shape of sporangia. FIGS. 31–33, persistent post-cleavage stage. FIG. 34, dehiscence and discharge of zoospores. FIG. 35, swimming zoospores.

FIGS. 36–51, *K. dubia.* FIG. 36, polyrhizoidal thallus with constricted, thick-walled rhizoids. FIGS. 37, 38, exit papillae with separated and pushed up opercula. FIG. 39, exit papilla of empty sporangium. FIGS. 40, 41, initial and advanced stages of dehiscence. FIG. 42, zoospores with coiled flagella. FIGS. 43, 44, oval, spherical and elongate zoospores. FIGS. 45, 46, 47, thick-walled, constricted and coiled rhizoids. FIGS. 48–51, encrusted, verrucose and smooth resting spores.

FIGS. 52–69, *K. lobata.* FIG. 52, polyrhizoidal thallus with thick, wrinkled sporangium wall and exo- and endoöpercula. FIG. 53, endoöperculum under deliquesced tip of exit papilla. FIG. 54, portion of a thick-walled, constricted rhizoid. FIG. 55, monorhizoidal thallus with an exoöperculate, wrinkled sporangium. FIG. 56, stalked endoöperculate sporangium. FIG. 57, young stage in the development of a stalked sporangium. FIG. 58, zoospores escaping in sticky strands from globular mass at orifice of exit papilla. FIG. 59, swimming zoospore. FIGS. 60, 61, elongate and amoeboid, creeping zoospores. FIGS. 62–69, variations in size and shape of resting spores.

FIGS. 70–78, *K. marylandia.* FIG. 70, polyrhizoidal thallus with appendiculate, endoöperculate sporangium. FIGS. 73, 71, initial and advanced stages of dehiscence. FIG. 72, monorhizoidal thallus with sporangium which has formed two successive opercula. FIGS. 74, 75, sporangia with long irregular exit tubes. FIG. 76, normal sized zoospores. FIGS. 77, 78, minute zoospores.

THE TAXONOMIC SIGNIFICANCE OF SPOROGENOUS BASAL CELLS IN THE UREDINALES [1]

M. J. Thirumalachar and George B. Cummins

Sporogenous basal cells in the uredia and telia of the plant rusts have been emphasized in recent years as structures of considerable taxonomic significance. A review of the genera *Chaconia*, *Chrysocelis*, *Scopella*, and *Maravalia*, together with synonymous genera, indicates that the importance of basal cells has been overemphasized.

The development of teliospores in clusters on basal cells was recognized by Juel (**3**) when he established the genus *Chaconia*. The genus *Olivea* Arth. develops similarly. Mains (**6**), in establishing the genus *Scopella*, utilized the presence of well-developed, laterally free basal cells as a characteristic of primary significance. The genus *Scopellopsis*, established by Ramakrishnan and Ramakrishnan (**9**), was segregated from *Maravalia* because of the presence of basal cells and paraphyses. In this method of sporulation the spores develop successively from a basal cell. Consequently, the spores in any one cluster are of unlike ages, as pointed out by Juel (**3**). In the genus *Puccinia* Kuhnholtz-Lordat (**4**) has designated this method of development as the fasciculate type.

It is frequently difficult to demonstrate the method of sporulation with certainty. In the telia of *Maravalia achroa* (Syd.) Arth. & Cumm., *Scopella cryptostegiae* (Vestergr.) Cumm., *Puccinia solmsii* P. Henn., *P. bottomleyae* Doidge, and *Xenostele indica* Trium. the basal cells are not conspicuously elongate and consequently are easily overlooked. This is not the case with *Scopella echinulata* (Niessl) Mains, *Sorataca amiciae* Syd., *Hapalophrag-*

[1] Cooperative investigations between the Purdue University Agricultural Experiment Station and the Division of Mycology and Disease Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. Journal Paper Number 384, of the Purdue University Agricultural Experiment Station. Contribution from the Department of Plant Pathology, University of Wisconsin and the Department of Botany and Plant Pathology, Purdue University.

mium milletiae Syd., *Desmella superficialis* (Speg.) Syd., and *Achrotelium lucumae* (Arth. & Johnst.) Cumm., species in which basal cells are elongate and readily demonstrable. In a third group of species, including *Scopella lucumae* (Diet.) Cumm., *Achrotelium ichnocarpi* Syd., and *Bitzea ingae* (Syd.) Mains, the teliospores are also clustered on basal cells but the latter are extremely difficult to observe because they are neither elongate nor laterally free. It is possible, using unrelated genera, not only to demonstrate the wide occurrence of basal cells, but also to prove the presence of intergradation.

The difficulties attending attempts to employ basal cells as structures of generic significance were discussed by Cummins (1) as follows: "Basal cells, as other morphological structures, are presumably subject to considerable variation. There is no rule by which one can definitely decide when basal cells cease to be basal cells and become parts of a cellular hymenium. This question does not arise in connection with the highly developed basal cells of *Scopella echinulata* (Niessl) Mains. It begins to enter when one studies *S. cryptostegiae* and *S. bauhiniicola*, however."

During this study telia of several species in different genera were examined for the presence of basal cells. These, together with species recorded or illustrated in the literature, but not previously mentioned in this paper, are listed below.

Name of rust	Authority	Development
Coniostelium quitensis	Sydow (10)	Prominent
Prospodium perodiosum	Cummins (2)	Prominent
Puccinia cynodontis	Kuhnholtz-Lordat (4)	Prominent
Puccinia polygoni	Kuhnholtz-Lordat (4)	Prominent
Sphenospora kevorkianii	Linder (5)	Prominent
Sphenospora yurimaguasensis	Present study	Prominent
Uromyces aleuropidis-repentis	Nattrass (8)	Prominent
Uromyces proeminens	Nattrass (8)	Prominent
Uromyces salsolae	Nattrass (8)	Prominent
Uropyxis amorphae	Present study	Prominent
Chrysopsora gynoxidis	Present study	Distinct
Maravalia achroa	Present study	Distinct
Mehtamyces stereospermi	Mundkur & Thirumalachar (7)	Distinct
Ravenelia spinosa	Present study	Distinct
Scopellopsis dalbergiae	Ramakrishnan & Ramakrishnan (9)	Distinct
Mainsia epiphylla	Present study	Obscure

In most of the rusts listed above the presence of basal cells has not been employed taxonomically but in the genera *Scopella*, *Chaconia*, *Scopellopsis*, and *Coniostelium* the basal cell provides the principal diagnostic character. Basal cells, together with more

important characters, are described in the genera *Tegillum, Desmotelium, Prospodium,* and *Olivea.*

The question arises as to how far the use of basal cells in the segregation of genera is justified. The structure obviously is variable and may be interpreted quite differently by different investigators studying similar material. If genera are to be differentiated because of the occurrence of basal cells a multiplicity of new genera for closely related rusts may result. Since the fasciculate type of development is now known to occur in unrelated genera it is doubtful if it should be accorded generic significance. We prefer to accept Kuhnholtz-Lordat's (**4**) conclusion that it merely represents one mode of spore development.

The telium is universally accorded primary importance in the characterization of genera of the Uredinales. It is our opinion that the spermogonium, an organ at least as conservative to change as is the telium, also provides a significant diagnostic character. There is little evidence that the spermogonia vary, within a genus, in their position relative to the epidermis. Exceptions apparently exist, however, in *Ravenelia* and *Melampsora* as currently constituted. A similar statement applies to telia, again with exceptions in *Ravenelia.*

Inasmuch as we consider that the presence of basal cells is not of generic significance the following key, based on other characters, is given to the group of genera in which basal cells have figured prominently.

Telia subepidermal or intraepidermal; teliospores one-celled, hyaline, germinating immediately by an external basidium; differentiated germ pore wanting.

Pycnia subcuticular
- Teliospores sessile ..... *Chaconia* Juel.
  (*Ypsilospora* Cumm.)
  (*Bitzea* Mains.)
- Teliospores stipitate ..... *Scopella* Mains.

Pycnia subepidermal
- Teliospores sessile ..... *Chrysocelis* Lagerh. & Diet.
- Teliospores stipitate ..... *Maravalia* Arth.
  (*Argomycetella* Syd.)
  (*Scopellopsis* Ramak. & Ramak.)

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THE GENUS HETEROCHAETE IN THE UNITED STATES

SISTER MARY CECILIA BODMAN

(WITH 4 FIGURES)

The tremellaceous genus *Heterochaete* was described by Patouillard (**4**) from material which Lagerheim had collected in Ecuador in 1892. The genus is essentially tropical or subtropical, and has been collected in or near the torrid zone in all parts of the world.

Fourteen collections have been recorded from the United States. The first of these was made by Langlois, in 1897, at Saint Martinville, Louisiana. Five other collections have been made in Louisiana, and six in Florida. One of the remaining collections is from Kentucky; the other from the District of Columbia. Burt regards the collection from the District of Columbia, which was made on the grounds of the United States Department of Agriculture, as an import, and the species he erected for it—*H. Shearii* (Burt) Burt—has been reported only once since, this time from Guam (**1**). The southwestern part of Kentucky is included in the old gulf embayment, in which the remnants of a tropical flora compete with oak-hickory forests, and with stands of beech and hard maple. A single specimen of *H. andina* was collected at Clinton, in this region.

Patouillard (**2**) established the species *H. sublivida* for the first collection made in the United States, that of Langlois in 1897. All other collections made in Louisiana have been determined as *H. andina*. One of the Florida collections, made near Miami by Thaxter, was determined by Burt as *H. andina*, and I have tentatively, on the basis of external appearance and the general aspect of the hymenium, assigned to the same species two collections from Florida which are a part of the Ellis Collection in the New York Botanical Garden. I have also determined as *H. andina* a collection made by C. L. Shear in Florida in 1937. Two collections made by R. Singer at or near Miami in 1942 are described in this paper as representing a new species.

Two types of fructification are found in the genus. One is distinctly gelatinous, appearing horny when dried. This type has not been reported from the United States, although the conspicuous *H. gelatinosa* (Berk. & Curt.) Pat. (**4**) has been found in Mexico. The second type, which characterizes all specimens thus far found in the United States, is coriaceous or farinaceous in aspect. All of these collections are moderately thick (more than 75 μ when dried), conspicuous, and heavily incrusted with mealy granules. The pegs are sometimes visible to the naked eye, and may always be seen if the specimen is examined with a hand lens. Some *Heterochaetes* have been identified as *Odontia, Hydnum* or *Hymenochaete*. It seems quite possible that if tropical collections of these genera are reexamined, some representatives of *Heterochaete* may be found.

I am indebted to Mr. John A. Stevenson, of the U. S. Department of Agriculture, for the loan of the type of *H. Shearii;* to Dr. H. S. Jackson, of the University of Toronto, for the specimen of *H. andina* collected by C. L. Shear, and to Dr. Donald P. Rogers, of the New York Botanical Garden, for the specimens from the Ellis collection. Dr. Rolf Singer, then of Harvard University, sent his Florida collections. It is with pleasure and with regret that I recall the courtesies extended to me at the Farlow Herbarium by Dr. David H. Linder. This work was done in the mycological laboratory of the State University of Iowa, under the direction of Prof. G. W. Martin.

Heterochaete Patouillard, Bull. Soc. Myc. Fr. **8**: 120. 1892.

Effused, resupinate, adnate, coriaceous to gelatinous, the hymenium pierced by irregularly distributed, infrequent or numerous sterile pegs consisting of fascicles of hyaline or faintly tinted parallel hyphae, compressed and partially gelatinized, arising from the subhymenium; subicular hyphae often extending beyond the hymenium to form a sterile, light-colored, villose margin. Aspect when dry, arid or somewhat farinaceous from the numerous granules which cover the surface, or horny; size and shape indeterminate, the fructifications often becoming confluent. Xeric, sometimes reviving to produce a second hymenium on top of the first. In section consisting of two distinct layers: a gelatinous, deeply-staining hymenium composed of basidia borne at or somewhat below the surface, of branching and contorted paraphyses, and

often of cystidia, or gloeocystidia, or both, and a subhymenium of interlaced, usually unbranched hyphae which may be gelatinized and indistinct or firm-walled, discrete, slightly refractive and tinted. A basal layer of parallel, more closely compressed hyphae sometimes present. Clamp connections occasionally observed. Basidia ovate or somewhat elongated, longitudinally or cruciately divided, bearing two or four epibasidia; spores suballantoid, with a prominent or sometimes small apiculus, germinating by repetition. Conidia rarely observed and then borne upon hymenial conidiophores.

Distinguished from all other resupinate, tremellaceous fungi by the presence of sterile hyphal pegs, which are usually conspicuous, numerous, and easily recognized.

The teeth or pegs that are found in other resupinate members of the Tremellaceae, for example in *Protodontia, Protohydnum,* and *Eichleriella,* are usually covered at least in part by the hymenium. Although spores may cling to the gelatinous parallel hyphae of the pegs of *Heterochaete,* those pegs are always completely sterile.

Proposed lectotype: *Heterochaete andina* Pat. & Lag. This species was the first described by Patouillard and Lagerheim. The material is adequate and is representative of the greater number of species that have been described. It appears also to be widely distributed.

KEY TO SPECIES

1. Fructification about 200 μ in thickness, brown; hymenium brown in section ..... 2. *H. crassa*
1. Fructification less than 200 μ in thickness, pale in color; hymenium colorless in section 2
   2. Fructification with a pinkish tinge, usually less than 100 μ in thickness; spores 10–18 μ in length ..... 1. *H. andina*
   2. Fructification not at all pink, usually 100–200 μ in thickness 3
3. Spores 14–17 μ in length; gloeocystidia present; pallid except for colored basal layer ..... 3. *H. Shearii*
3. Spores 8–12 μ in length; gloeocystidia absent or inconspicuous; fructification dull, without colored basal layer ..... 4. *H. sublivida*

1. HETEROCHAETE ANDINA Pat. & Lag., Bull. Soc. Myc. Fr. **8**: 120. 1892.

Fructification thin, usually 50–100(–150) μ, surface dull, covered with coarse, mealy granules, pinkish buff to pinkish cinnamon, occasionally cartridge buff; pegs blunt, rather thick, usually

darker than the hymenium, hyphae appearing brownish under the microscope and slightly gelatinized; subhymenium indistinct, gelatinized, colorless, occasionally bearing clamp connections; hymenium often appearing to rise directly from the substrate, composed of characteristic gelatinized paraphyses, basidia and cystidia; gloeocystidia occasionally present, colorless, sometimes clustered and numerous; basidia two- or four-celled, ovate, 15–20 × 6–8 μ; spores allantoid or suballantoid, (10–)14–17(–18) × (4–)5–6 (–8) μ. Conidia (?) occasionally observed.

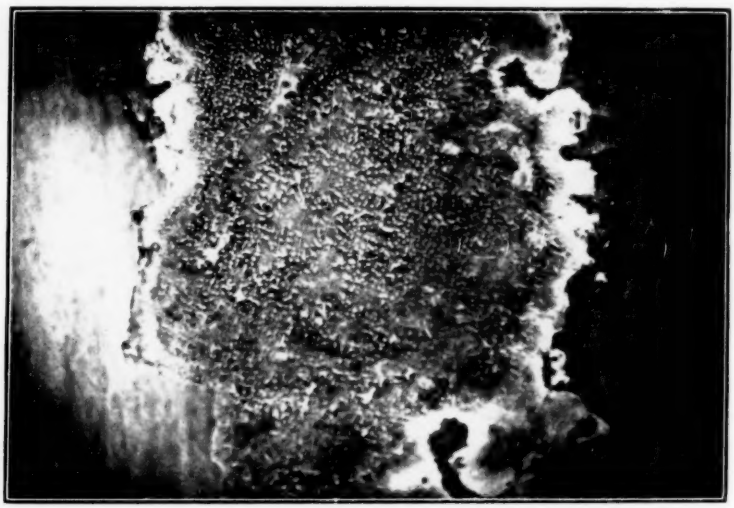

FIG. 1. *Heterochaete crassa*, × 4. (Type)

Type locality: Ecuador.

Distribution: Kentucky, Florida, Louisiana; Puerto Rico, Costa Rica, Mexico, Panama; Ecuador, Argentina, Brazil.

Specimens examined:

Ecuador, Cotocallao, 1892. Lagerheim. FH. TYPE.
Florida, Cocoanut Grove. Thaxter, *93*. FH.
Florida, Highlands Hammock, 1937. Shear, *244*. Tor.
Florida. Calkins, *663* and *664*. NYBG.
Louisiana, St. Martinville, 1899. Langlois, *2855*, *2988* and *ah*. FH.
Louisiana, New Orleans, 1908. Earle. NYBG; FH.
Kentucky, Clinton, 1925. *9262*. FH.

2. **Heterochaete crassa** sp. nov.

Fructificationibus resupinatis, primo orbicularibus, deinde latissime effusis, confluentibus, aridis in statu sicco, farinaceis, brunneis, dense setulosis; in margine albidis claris, villosis; setulis concoloratis, 160 μ altis; in sectione 150–400 μ crassis; hyphis subhymenialibus haud ramosis, distinctis, non gelatinosis, subcoloratis, minime zygodesmatibus, 2.5 μ diametris, accensis a subiculo tenue, hyalino; hymenio gelatinoso, in sectione fulvo; paraphysibus contortis, ramosis; gloeocystidiis typicis, hyalinis; cystidiis non visis; probasidiis ovatis, 19–21 × 11 μ, cruciatim partitis; maturis 18–27 × 10–15 μ; sporis 14 × 8 μ.

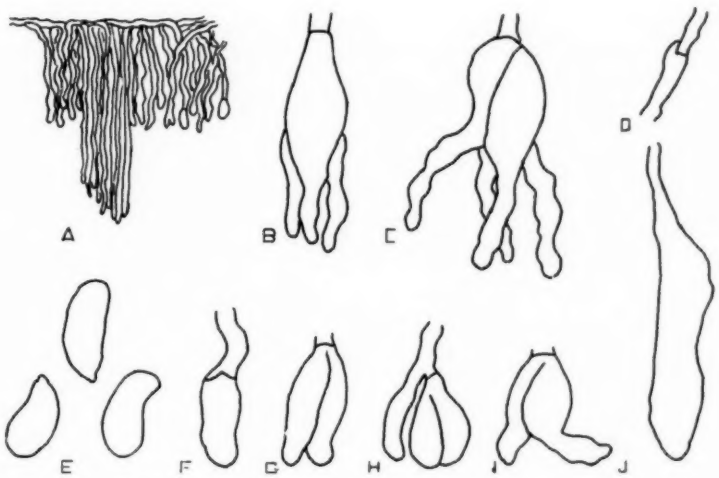

FIG. 2

a. Heterochaete andina, cross-section of fructification, ×170; *b, c, f–i.* Basidia (b, c. Type); *d.* Hypha with clamp connection; *e.* Spores; *j.* Gloeocystidium. All × 1000.

Fructifications 150–400 μ in thickness, Verona brown to cinnamon brown in the herbarium, walnut brown when fresh, pegs tapering slightly to the apex, concolorous with the hymenium, surface dry and farinaceous, the entire hymenial surface heavily incrusted with granules that cling to paraphyses, basidia, spores, and the hyphae of the pegs; margin white or light-colored, mycelioid, contrasting conspicuously with the dark hymenium; hyphae of the subhymenium discrete under the microscope, not at all gelatinized, 2.5 μ in diameter, unbranched, very faintly tinted; clamp connections occasionally seen; basal layer of finer thin-

walled hyphae, colorless, compressed; hymenium and pegs after treatment with KOH a clear, golden brown; paraphyses contorted, branching; gloeocystidia colorless; no cystidia seen; probasidia oval, 19–21 × 11 μ; basidia four-celled, when mature 18–27 ×10–15 μ.

Type locality: Florida.

Distribution: Known only from the type locality.

Specimens examined:
Florida, Miami, 1942. Singer, *1494*. FH. TYPE.
Florida, Matheson Hammock, 1942. Singer, *1355*. FH.

The robust form, dark color, and hymenium appearing deeply colored under the microscope make this fungus seem conspicuously different from any other species found in the United States.

3. HETEROCHAETE SHEARII (Burt) Burt, Ann. Missouri Bot. Gard. **8**: 377. 1921.
Sebacina Shearii Burt, Ann. Missouri Bot. Gard. **2**: 758. 1915.

Surface dull in color, pruinose or farinaceous; texture coriaceous, dull white, drying olive buff; pegs scarce in the type specimen, darker than the hymenium, made up of a central sheaf of brownish hyphae which arise in the layer next to the substratum; subhymenium of distinct, lightly tinted hyphae in which no clamp connections have been observed; hymenium composed of branching paraphyses, basidia located somewhat below the surface, and conspicuous and rather numerous gloeocystidia, which exceed the basidia but which never rise above the surface; basidia approximately 15 × 9–10 μ; spores 9–15 × 4.5–6 μ.

Type locality: District of Columbia.

Distribution: District of Columbia; Guam.

Specimens examined:
District of Columbia, Washington, 1902. Shear, *1238*. USDA. TYPE.
Guam, 1919. Edwards, 10778. Herb. MBG; FH.

There are so few of the characteristic hyphal pegs present in the type specimen that four or five sections may be mounted without a single peg being seen. It is not surprising that Burt at first described this as a *Sebacina*. The pegs are more numerous in the specimen from Guam.

4. HETEROCHAETE SUBLIVIDA Pat., Bull. Soc. Myc. Fr. **24**: 2. 1908.

H. Burtii Bres., Ann. Myc. **18**: 51. 1920.

Fructification coriaceous, lightly incrusted with mealy granules, drab, the pegs inconspicuous and lighter in color than the hymenium, heavily incrusted; subhymenium inconspicuous, colorless; hymenium of typical paraphyses and basidia, no cystidia or gloeocystidia observed; basidia broadly ovate, (16–)20(–24) × 8–10 μ; spores 8–11 × 5–6 μ.

Type locality: Louisiana.

Distribution: Known only from the type locality.

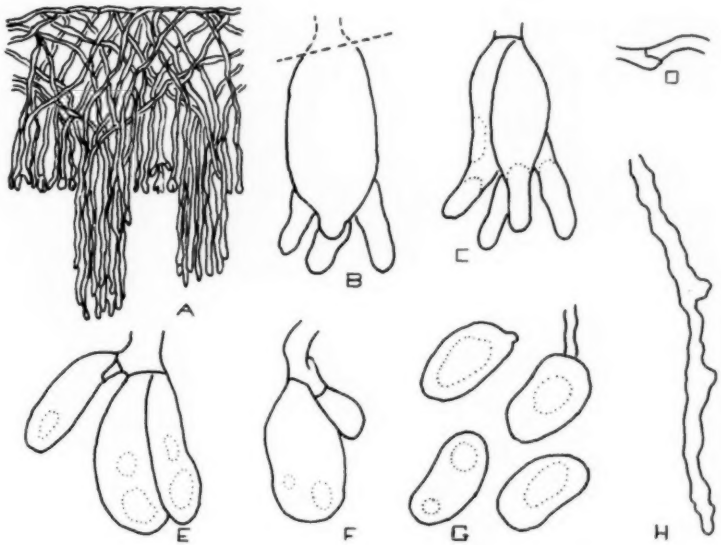

FIG. 3. (All drawings from type collection)

a. Heterochaete crassa, cross-section of fructification, × 60; *b, c, e, f.* Basidia; *d.* Detail of hypha, showing clamp connection; *g.* Spores; *h.* Paraphysis. All × 1000.

Specimens examined:

Louisiana, St. Martinville, 1897. Langlois, *2882*. FH. *Cotype*.

This species is noticeably duller in color than is any other species occurring in the United States.

It will be noted that *H. andina, H. Shearii* and *H. sublivida* seem to intergrade, and there at once arises the question of whether or not these are good species. Not all three may be valid. Four or five characters appear to differentiate them: (1) The presence of gloeocystidia in *H. andina* and *H. Shearii,* but not in *H. sublivida;* (2) a pronounced pinkish tinge in *H. andina,* whereas the other two are more subdued in color; (3) an inconspicuous,

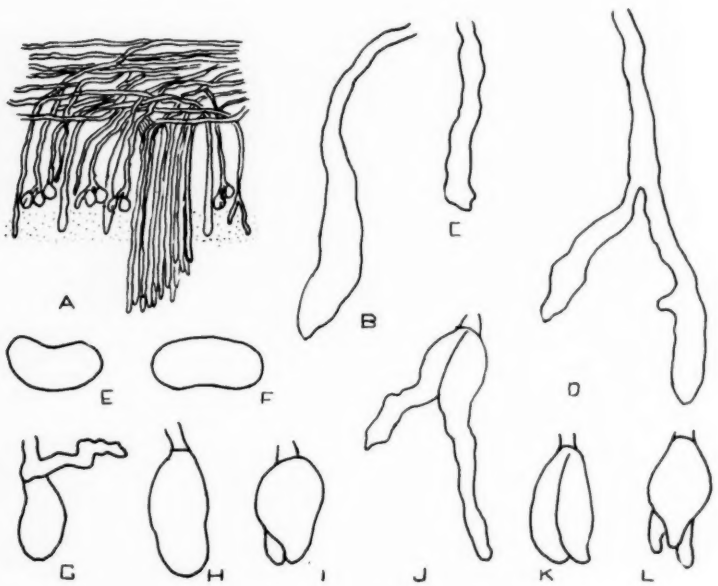

FIG. 4. (All drawings from type collection)

a. Heterochaete Shearii, cross-section, × 170; *b.* Gloeocystidium; *c, d.* Paraphyses; *e, f.* Spores; *g–l.* Basidia. All × 1000.

gelatinous, colorless subhymenium in *H. sublivida* and *H. andina,* contrasted with a firm, slightly-tinted, easily identifiable one in *H. Shearii;* and (4) a range of spore size in *H. andina* so wide that it includes also *H. Shearii* and *H. sublivida.* The basidia of *H. Shearii* are also smaller than are those of the other two. A complicating factor is that *H. sublivida* and *H. Shearii* have been

but rarely collected, and therefore accurate knowledge of the amount of variation in these two species is not available.

Color is certainly not a dependable species character, particularly when the color variation is merely a small difference in shade. Cystidium and gloeocystidium are terms in need of more precise delimitation. *H. Shearii* seems to possess both cystidia and gloeocystidia, although Burt in his vivid descriptions mentions only gloeocystidia. Neither cystidia nor gloeocystidia are mentioned for *H. andina* and *H. sublivida* and I have been able to find neither in *H. sublivida,* but long, slender, colorless organs arising beneath the hymenium and extending through it, occasionally becoming apparent above the surface, are easily demonstrated in almost every specimen of *H. andina.* In the specimen collected by F. S. Earle in New Orleans they seem to be clustered, and are very numerous. These I interpret as gloeocystidia. Patouillard in discussing the genus (**3**) remarks, "Parfois des cystides éparses ou groupées au sommet des émergences," but I have found nothing that will meet this description. Attempts to segregate the species of this genus upon the basis of organs so poorly defined are, to say the least, precarious.

Other histological characters may be of more significance. The spores of *H. sublivida* seem to be noticeably smaller and plumper, the basidia somewhat larger than those of the other two species. In contrast with this, the structure of the subhymenium of *H. Shearii* seems much different from that of *H. andina* and *H. sublivida.* The smaller spores of *H. andina* have been found in only one collection—that of F. S. Earle in New Orleans. These are accompanied by small basidia, and by the numerous and conspicuous gloeocystidia that were previously mentioned. It does not seem unreasonable to suggest that when African and Asian collections are interpolated into the American series a continuous, smoothly-blending succession of characters which indicate a single species may be the result. However, further study of the type material, and of other collections from both hemispheres, is indicated before any decision is made.

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3. ——. Essai taxonomique sur les familles et les genres des hyménomycètes. Lons-le-Saunier. 1900. 184 pp.
4. —— **et G. de Lagerheim.** Champignons de l'équateur. Bull. Soc. Myc. Fr. **8**: 120. 1892.

CATACAUMA SABAL CHARDON IDENTIFIED IN THE UNITED STATES AND MEXICO

DONALD P. LIMBER AND ANNA E. JENKINS[1]

(WITH 2 FIGURES)

An ascomycete on three specimens of *Sabal* leaves taken in connection with plant-disease surveys of the United States Department of Agriculture (*cf.* **2** and **4**) was identified as *Myriangium sabalcos* Weedon (**5**). Our further study of this myriangiale appears in a companion paper (**3**). We are here presenting our more or less parallel study of a dothideale, *Catacauma sabal* Chardon, which we found in abundance on two of the specimens referred to above. Previously this has not been distinguished from the myriangiale, and to our knowledge *C. sabal* has not been reported from other than the type locality, which is the Dominican Republic.

Two specimens on which we identified the myriangiale were from Georgia (**2**), *viz.* on *Sabal palmetto,* Richmond Hill, December 9, 1943, A. W. Blizzard *890;* and on *Sabal minor,* Savannah, December 31, 1943, A. W. Blizzard and Ilo Hein (Blizzard *943*). On the young green leaves from Richmond Hill we noted only the myriangiale (FIG. 1, *E* and *F*); on the other specimen, however, we soon discovered that another ascomycete, a dothideale, was present in abundance. The third specimen of diseased *Sabal*

[1] We are grateful to the curators of the herbaria at Ithaca, N. Y., and at Urbana, Ill. (see footnote 3), for the privilege of examining type material deposited in these herbaria. We are indebted also to Flora G. Pollack, formerly of the Bureau of Entomology and Plant Quarantine (for a time stationed at Hoboken, N. J., later at Beltsville, Md.), for obtaining additional material of the *Catacauma;* to Clark T. Rogerson and L. M. Massey for obtaining the photographs of the type of the species; and to C. E. Chardon for verifying our determination of the species. We wish also to express our thanks to those who made the photographs, W. R. Fisher (FIG. 1, *H–J*), M. A. Jaeger (FIG. 1, *D*), and R. L. Taylor (FIG. 1, *A–C*, *F* and *G*).

taken during the survey was collected on *S. etonia* at De Soto City, Florida, by A. S. Rhoads, October 27, 1943 (**4**). On this specimen are the colorful ascomata of the myriangiale (FIG. 1, *G*), identified by Erdman West as *Myriangium sabalcos,* but much more numerous are the fructifications of the dothideale (FIG. 1, *C*). The same condition is true of the type specimen of *M. sabalcos.* This specimen also is from Florida, where it was collected on *S. palmetto* at St. Petersburg, February 13, 1923, by the author of the species.

That this fungus is widespread is further shown by three additional specimens now available. All are free from the myriangiale. One is an interception of diseased palm leaves from Mexico made at Brownsville, Texas, on April 27, 1946, by W. C. Edgeworth (Brownsville *61009*). This specimen was first examined by Flora G. Pollack, who had been present in 1944 when Blizzard *943* was examined by Limber and had been shown the preparations of both the dothideale and the myriangiale. Ascertaining that the fungus on the Mexican specimen was dothideaceous and that the conidial stage associated with it was the same as that on Blizzard *943,* Mrs. Pollack identified it as near *Phyllachora* or *Catacauma.* Since it seems to be the dothideale in question, we are suggesting that the palm may be a *Sabal.*

The other two additional specimens are both on *Sabal texana* from Brownsville, Texas, *viz.* November 17, 1945, Robert Runyon *4093,* and March 7, 1947, D. J. Smith. On the label of Runyon *4093* is essentially this statement: "It advances from the apex of the leaf toward the base, causing the leaf margins to die. It is only occasional on *Sabal texana.* In Brownsville, this palm is cultivated along sidewalks." Following Mrs. Pollack's examination (at Beltsville) of Brownsville *61009,* she also recognized the dothideale on Runyon *4093.* Mr. Smith's gathering, which we received while it was still fresh, was made at her behest. It was upon receiving this specimen of the dothideale that we actually undertook to identify it.

Pustules of the dothideale are abundant, especially so on the specimens of *Sabal texana* (FIG. 1, *A* and *B*). They are more conspicuous on the upper leaf surface and often do not penetrate to the lower surface, or are visible only as small blisters somewhat

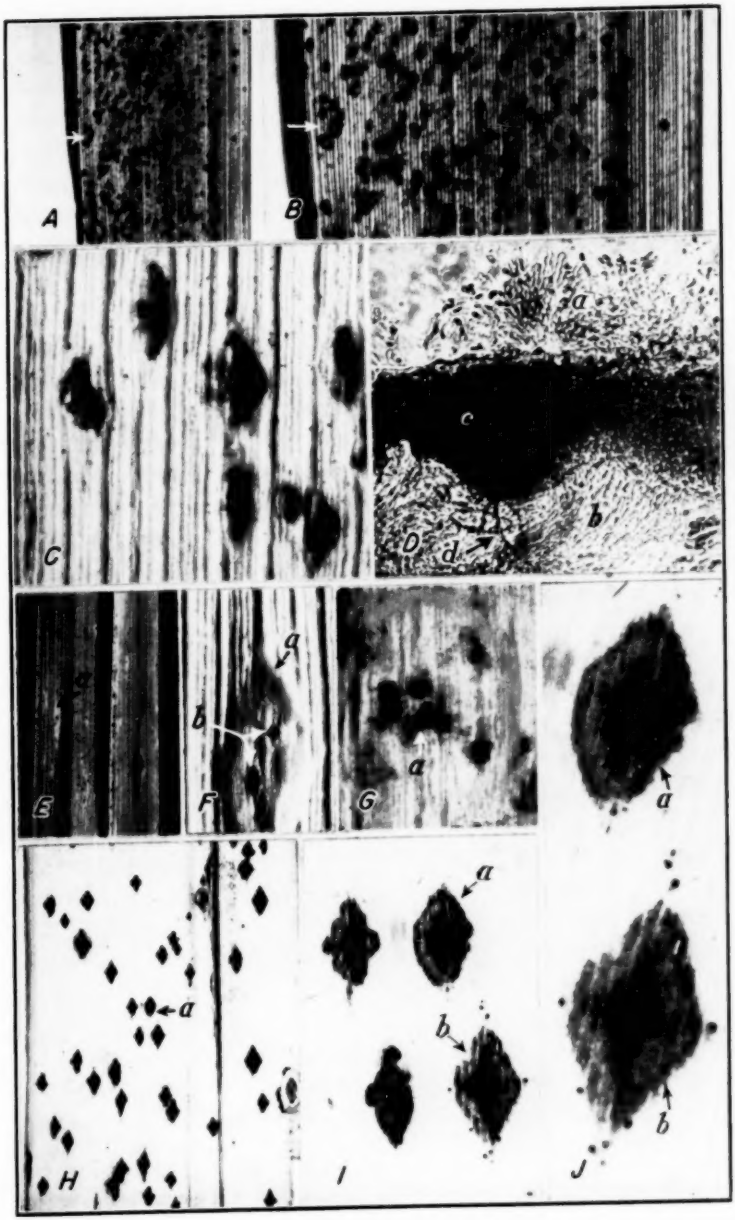

FIG. 1. *Catacauma sabal.*

paler than the surrounding leaf surface. Viewed en masse on the Texas specimens the pustules have a "seal brown" [2] cast. Individually they are pale to buffish brown, or black. The leaf tissue immediately surrounding the spot may not be discolored, or it may be whitish to brown. On the Rhoads specimen the spot often penetrates the leaf, and a pustule is present on each leaf surface.

Morphologically the dothideale is so different from the myriangiale [compare FIG. 2 with FIG. 2 (3)] that examined microscopically the two unrelated ascomycetes may be readily distinguished. We feel certain that Weedon's not having noticed the more abundant dothideale on the type specimen of her myriangiale, and likewise West's not having discovered it on the Rhoads specimen, is attributable to the similar superficial aspect of the two ascomycetes [compare FIG. 1, *C*, with FIG. 1, *A* (3)]. Where visible [FIG. 1, *G*, and FIG. 1, *a* (3)], stromata of the myriangiale are readily recognized by their red to purple color, such as "pomegranate purple" or "Bordeaux." Pustules of this fungus, where present, are interspersed haphazardly among those of the more abundant dothideale or the two may be in juxtaposition. In the young or poorly developed fructifications of either species, it may be difficult or practically impossible, even in microscopic mounts, to determine which is present or whether both are involved.

Our identification of the dothideale in 1947 was simplified by the fact that only the year before Chardon (1) had described as *Catacauma sabal* a fungus that he had collected on dead leaves of *Sabal umbraculifera* (Jacq.) Martius (det. L. H. Bailey, fide Chardon, letter July 17, 1948), in the Dominican Republic, July 11, 1937. To verify our determination we corresponded with Dr. Chardon, who wrote that the structure of the fungus and the measurements of the spore were in agreement with his description, and stated that the type was at Cornell University. The type was photographed for us under the direction of Clark T. Rogerson (FIG. 1, *H–J*) and subsequently examined at Ithaca by Limber.

The specimen consists of four leaf fragments—two faded nearly white, the other two tan. On the whitish fragments are the large

[2] Colors quoted are based on Color Standards and Color Nomenclature, by R. Ridgway. 43 pp. Washington, D. C.

diamond-shaped spots shown in our figure 1, *H–J*, and as illustrated by Chardon (**1**, FIG. 14). On the two other leaf fragments are a few spots; however, the pustules are mostly of varying smaller sizes and crowded. In the sections made, some locules were filled with ascospores. This material was too old to distinguish more than the ascus walls. It was impractical, therefore, to look for the funnel-shaped depression above the pore of the ascus that we had noted on the fresh specimen from Texas (FIG. 2, *C*).

In some sections of the *Catacauma*, hyaline wefts of hyphae, possibly paraphyses, pass from the locules to the surface of the pustule (FIG. 1, *D*). Black, punctate incrustations, sometimes present on pustules of the *Catacauma*, consist of more or less radiating hyphae connected by a hyphal column to the stroma beneath. These have been examined many times and have always been found to be sterile.

In order to accommodate Chardon's description to the new details of morphology observed during our study of additional material, we append the following emended description.

CATACAUMA SABAL Chardon, Farlowia **2**: 461, *figs.* 14–17. 1946, *emend.* Limber and Jenkins (FIGS. 1, *A–D* and *H–I*, and 2)

Stromata conspicuous, amphigenous (on *Sabal texana* concentrated on one leaf surface, usually the upper), slightly to abruptly raised, pale to dirty brown or black, en masse sometimes purplish in cast, visible below by a pale or yellowish fleck, 1–3 × 0.5–1.5 mm., main axis following that of the leaf, immediately surrounding tissue sometimes "pinkish buff" or browned without a definite marginal zone, mature stromata subepidermal or rarely in the mesophyll, consisting of a heavy black clypeus, with no stromatic tissue below or at the margin, and up to 10 labyrinthiform locules, 200–420 × 93–132 μ, which converge from the periphery toward the central locule; asci clavate, 8-spored, pedicel short, apex flattened and indented by a funnel-shaped depression leading to the pore (seen only in fresh material), 68–85 × 35–43 μ, with spores at first distichous, then crowded into the upper part of the ascus; ascospores 1-celled, hyaline, navicular, 25–36 × 7–12 μ, mostly 27–30 × 8–10 μ, with the contents slightly granular; paraphyses filiform, scarce; conidial stage occasionally present, acervuli subepidermal, erumpent, conidiophores hyaline, subulate, in a palisade, 4–7 × 3 μ; conidia hyaline, obclavate, 4.5–6 × 2–3 μ.

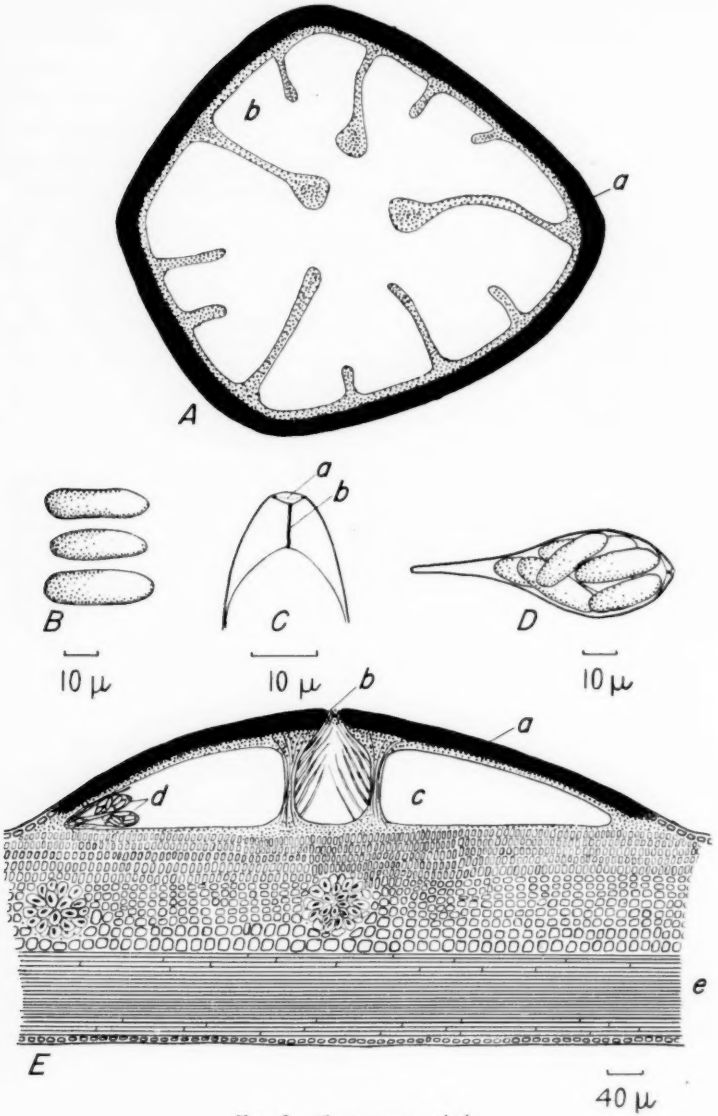

FIG. 2. *Catacauma sabal.*

Distribution and specimens examined:

Dominican Republic: On dead leaves of *Sabal umbraculifera* (Jacq.) Martius, Prov. Barahona, near the sulphur springs beyond Duvergé, July 11, 1937, Chardon (No. 760, Explorations of the Dominican Republic) (type). CU.[3]

Florida: On living leaves of *Sabal etonia* Swingle ex Nash, De Soto City, October 27, 1943, A. S. Rhoads. *Myriangium sabalcos* Weedon (**5**) also present on this specimen and previously identified as such (**4**). The *Catacauma* is much more abundant. USM.[4]

On the leaves of *Sabal palmetto* (Walt.) Lodd, St. Petersburg, February 15, 1923, A. G. Weedon. Although this is the type of *Myriangium sabalcos*, the *Catacauma* is the more abundant. NY, UI, USM.

Georgia: On green leaves of *Sabal minor* (Jacq.) Pers., Savannah, December 31, 1943, A. W. Blizzard *943*. *Myriangium sabalcos* also present and previously reported (**2**). USM, H.

Mexico: On palm (*?Sabal*) leaves, intercepted at Brownsville, Texas, April 27, 1946, by W. C. Edgeworth (Brownsville *61009*). USM.

Texas: On living leaves of *Sabal texana* (Cook) Becc., Brownsville, November 17, 1945, Robert Runyon *4093;* March 7, 1947, D. J. Smith. USM, H.

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2. **Fields, W. S.** Summary of the more important plant diseases taken in connection with the insect and plant disease survey in the general vicinity of ports of entry from July 1, 1944 to December 31, 1944. Plant Disease Rptr. **29**: 181–183. 1945. [Processed.]

[3] Herbaria in which the specimens examined are deposited are indicated as follows:

CU Herbarium, Department of Plant Pathology, Cornell University, Ithaca, N. Y.
NY New York Botanical Garden, New York 58, N. Y.
UI Herbarium, Department of Botany, University of Illinois, Urbana, Ill.
USM Mycological collections of the Bureau of Plant Industry, Soils, and Agricultural Engineering, Beltsville, Md.
H Pathological Herbarium, Bureau of Entomology and Plant Quarantine, Hoboken, N. Y.

[4] Duplicates of this specimen are being deposited in CU, NY, and UI.

3. **Limber, D. P., and A. E. Jenkins.** Weedon's *Myriangium* on *Sabal*. Mycologia **41**: 545–552. 1949.
4. **Rhoads, A. S.** Summary of observations on plant diseases in Florida during the emergency plant disease prevention project survey July 25 to December 31, 1943. Plant Disease Rptr. Sup. **148**: 262–276. 1944. [Processed.]
5. **Weedon, A. G.** Some Florida fungi. Mycologia **18**: 218–223. 1926.

EXPLANATION OF FIGURES

FIG. 1. *A–D, Catacauma sabal* on leaves of *Sabal: A*, the dothideale in its general appearance on *S. texana*, Brownsville, Texas, March 7, 1947, D. J. Smith; × 1. *B*, part of *A*; × ca. 2½. *C*, several fructifications on the specimen of *S. etonia* from De Soto City, Florida, October 27, 1943, A. S. Rhoads; × 10. *D*, section of a fructification showing hyaline *Tubercularia*-like mass of hyphae (*a*) protruding from the ascus cavity beneath (*b*); *c*, clypeus; *d*, free ascospores; × ca. 225. *E–G, Myriangium sabalcos* for comparison with the *Catacauma*. *E*, inconspicuous spots on young leaf of *S. minor*, Richmond Hill, Georgia, December 9, 1943, A. W. Blizzard; × 1. *F*, single leaf spot from same source (*a*), showing ascomata (*b*); × ca. 8. *G, ascomata* (*a*) on the Rhoads specimen cited above; × 10. *H–J*, fructifications of the *Catacauma* on *Sabal umbraculifera*, Dominican Republic, July 11, 1937, Chardon *760 (type)*: *H*, × 1; *I*, same as *H*, *a*, × 5; *J*, *a* and *b*, same as *I*, *a* and *b*, × 10. Photographs by R. L. Taylor (*A–C* and *F* and *G*), by Limber (*E*), by M. A. Jaeger (*D*), and by W. R. Fisher (*H–J*).

FIG. 2. *Catacauma sabal*. *A*, horizontal section through a fructification showing the clypeus (*a*), and arrangement of the locules (*b*), as well as their incomplete separation; × ca. 100. *B*, three ascospores; × 500. *C*, apex of an ascus from the fresh specimen from Texas showing funnel-like depression (*a*), above the pore (*b*); × 1000. *D*, young ascus with spores; × 500. *E*, vertical section showing the location of the fructification beneath the epidermis: *a*, clypeus; *b*, ostiole; *c*, locule; *d*, asci in locule; *e*, leaf tissue; × 100. Drawings from Texas specimen by Limber.

WEEDON'S MYRIANGIUM ON SABAL

DONALD P. LIMBER AND ANNA E. JENKINS[1]

(WITH 2 FIGURES)

Weedon's *Myriangium sabalcos* (**10**) was described on the basis of a specimen she collected on leaves of *Sabal palmetto* at St. Petersburg, Florida, on February 15, 1923. In 1943 the fungus was again collected on *S. etonia* at De Soto City, Florida, by A. S. Rhoads (**7**, *p.* 275) and in Georgia on *S. palmetto* at Richmond Hill and on *S. minor* at Savannah, by A. W. Blizzard (**2**). The specimen from Richmond Hill shows only the myriangiale. The other two specimens of 1943, as well as the type specimen, were probably collected for the more conspicuous and much more abundant dothideale fruiting on them. Of these two parasites, only *Catacauma sabal* Chardon, as we have identified the dothideale (**4**), is known to cause any appreciable harm.

The actual leaf spots produced by the so-called *Myriangium* are usually small and insignificant. On the dry, young leaf fragments of the specimen of *Sabal palmetto* from Georgia, they are elongate, 0.25 × 1.3–5 mm., with the longer diameter paralleling the leaf axis. They are slightly thickened, minutely wrinkled lengthwise, pale, sometimes "pinkish buff,"[2] with a definite margin.

[1] In the present study we have had the advantage of examining type material, including microtome sections of the myriangiales described by Stevens and Weedon (**9**) and of Weedon's *Myriangium sabalcos* (**10**) deposited in the herbarium, University of Illinois. We wish to thank Leland Shanor, curator, for so graciously lending us this valuable material. Likewise, we wish to express our appreciation to Fred J. Seaver, curator of the New York Botanical Garden, for permitting us to examine the specimen deposited in the Garden's mycological herbarium. We are indebted also to Paul E. Tilford for obtaining for us Miss Weedon's present name and address (see footnote 4). To her we are most grateful for help in tracing the source of the heretofore overlooked error in the generic name of her myriangiale on *Sabal* as it appears in the original description.

[2] Colors in quotation marks are based on Ridgway, R., Color Standards and Color Nomenclature. 43 pp. Washington, D. C.

Ascomata, or stromata, of the myriangiale develop on both leaf surfaces, although they are more abundant as well as more prominent on the upper side. Often sparse and scattered, they may be plentiful in limited areas appearing singly or in groups; more rarely a few may be coalescent (FIG. 2, *A;* also see **4**, FIG. 1, *G*). They are circular to subcircular, elliptical or verruciform, reaching 225–750 μ long by 200–500 μ wide, and 65–200 μ thick. Stromata on the young leaf growth of *Sabal palmetto* from Georgia are whitish, but on the other older specimens they are distinguishable by their bright coloration, "carmine" to purple—"amaranth pur-

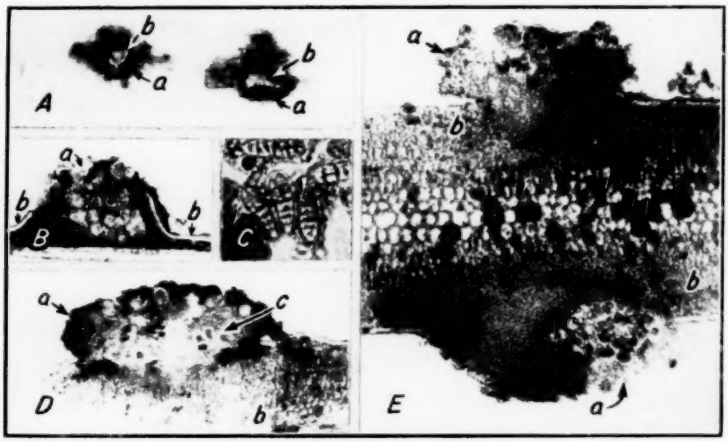

FIG. 1. *Myriangium* on *Sabal.*

ple," "pomegranate purple," or "burnt lake." Sections reveal that the ascomata form in or beneath the epidermis (FIG. 1, *B*) or in the mesophyll becoming superficial (FIG. 1, *A, b; B,* and *D*), although they may remain internal. Dense, hyaline hyphae within the leaf structure may lead from the base of one erumpent ascoma to that of another on the opposite side of the leaf (FIG. 1, *E*). Such a development in *Myrianginella tapirae* is reported by Stevens and Weedon (**9**, FIG. **7**), who termed it a "double ascoma." The bright coloration of the ascoma is limited to the peripheral region. Within, the pseudoparenchymatous tissue is hyaline to dilute olivaceous. In some sections, however, the entire mass including

the ascospores becomes stained red to purple from the coloring matter in the outer part of the stroma.

The numerous asci are distributed irregularly throughout the stroma, but in external fructifications may be concentrated toward the outer part. The asci are subspherical to obovoid, 21–29 × 17–23 μ, and the gelatinous wall is noticeably thickened (FIG. 2, *C*). Ascospores are clavate, straight or curved, and muriform, with three to five transverse walls and one or two longitudinal septa (FIG. 2, *E*). In one instance an incomplete longitudinal septum was observed (FIG. 2, *E*) and such has been noted by Petrak (**6**) in *Myrianginella tapirae*. A layer of awl-shaped conidiophores bearing hyaline conidia (FIG. 2, *D*) has several times been seen in locules in the stroma (FIG. 2, *F, b*). From its close association with the myriangiales, it seems that it must belong to that fungus.

As co-author with Stevens in describing three similar species of myriangiales and discussing their position in the order on the basis of Theissen and Sydow's classification (**8**), Weedon was in a unique position to describe the similar myriangiale on *Sabal*. However, she was handicapped by the presence of the *Catacauma* in an old state of development and by the sparseness of the myriangiale. Her slide made from microtome sections shows that the ascoma of the myriangiale may become superficial. This character and the reddish to purple coloration of the asconata would have placed the fungus in the genus *Myrianginella* created by Stevens and Weedon to describe their *M. tapirae*. They separated *Myrianginella* from *Myriangina* (Henn.) Hoehn. on the basis of the superficial development of the ascoma in *Myrianginella* and its intramatrical development in *Myriangina*.

In discussing the genus *Myrianginella* in 1927, Petrak (**6**) removed Stevens' basis for separating the two genera by reporting a superficial ascoma for *Myriangina mirabilis* (Henn.) Hoehn., type of *Myriangina*. This ascoma is illustrated by Jenkins (**3**, *pl. 2, A*), who noted also a copious development of asci in internal stroma of this species (**3**, *p.* 3). Calling attention to the fact that in *Myriangina mirabilis* the fructifications are pale yellow, Petrak disposed of *Myrianginella tapirae* by transferring it provisionally

to the genus *Uleomyces,* in which the fructification is also red to purple.

Rhoads (loc. cit.) alluded to Miller's (**5**) statement that *Myriangium sabalcos* "does not belong to" *Myriangium.*

Stevens and Weedon's account, together with Weedon's description of her myriangiale on *Sabal,*[3] led us to believe that Weedon actually intended to describe this in the genus *Myriangina.* When we referred to the type specimen, we found it labeled "*Myriangina sabalcos* n. sp. Weedon." The error represented in the published description was explained by Miss Weedon (Mrs. Amy G. Weedon Moore) upon our corresponding with her. She wrote:[4] "In the original manuscript as well as in the first typewritten copy the name appears as *Myriangina sabalcos.* However, on the copy sent the printer I find that the name has been changed to *Myriangium.* Who is or was responsible I do not know. The writing is not mine, nor does it look like Dr. Stevens'. The proof was evidently checked with this copy and thus the error slipped by."

Without further discussion of the genus *Myriangina* at this time, except to call attention to the large size of the ascus and ascospores as compared with those of *Myriangium sabalcos* (compare FIG. 2, *A* and *B,* with *E* and *C*), we are transferring this species to *Myrianginella.* In so doing we are not recognizing Petrak's provisional transfer of the type of *Myrianginella* to *Uleomyces,* but are revising the description of *Myrianginella.* We are also revising the description of *Myriangium sabalcos* in conformity with its morphological characters as we have observed them during the present study.

[3] This is here quoted for convenience of reference:

Myriangium sabalcos Weedon, sp. nov.

The stromata appear as small, black, slightly raised excrescences, 0.1–0.5 mm. in diameter; perithecia immersed, becoming erumpent, 300–900 × 230–300 μ; asci 95 × 18–21 μ, 8-spored; spores muriform, 3–5 transverse septa and 2–3 longitudinal walls, 21–26 × 7 μ.

On *Sabal palmetto,* St. Petersburg, Florida, Feb. 15, 1923, No. 2 (type).

The black excrescences are surrounded by a pale zone, 1–2 mm. in diameter. The spots are visible from both sides of the leaf. The asci when first released are incased in a tough sheath, forming almost spherical bodies, 24–27 × 25–28 μ. These sheaths are frequently found in the Myriangiaceae.

[4] Letter of September 12, 1944, addressed to Jenkins.

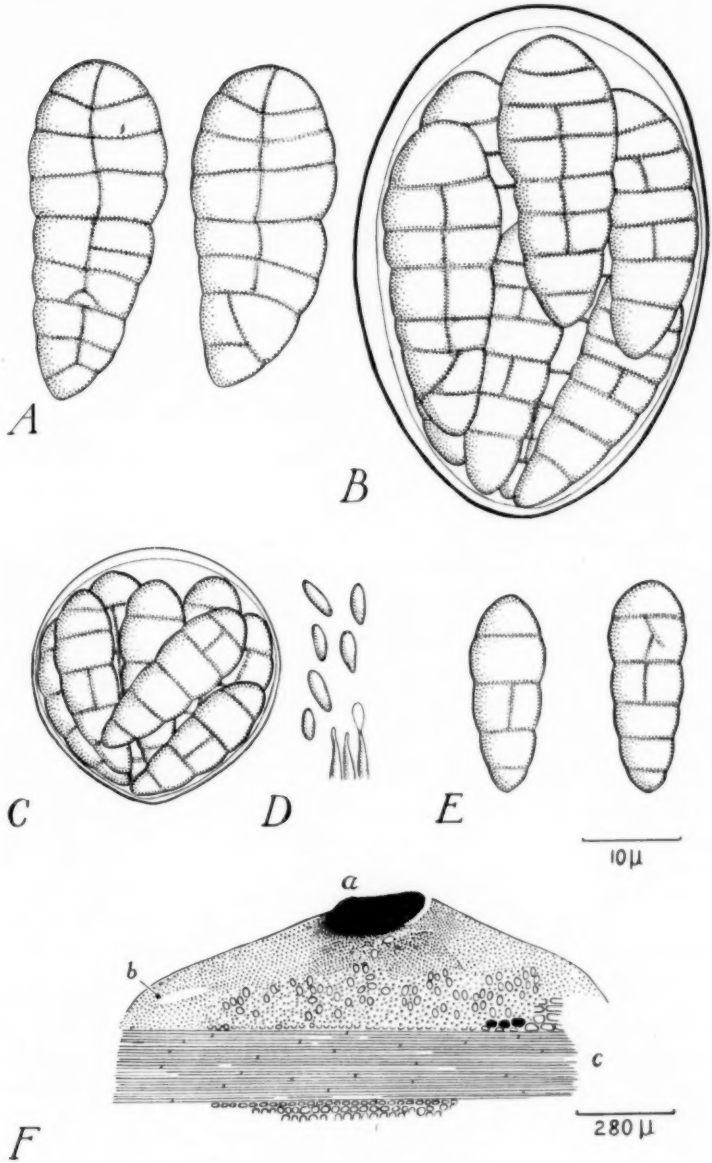

FIG. 2. *Myriangium* on *Sabal*.

MYRIANGINELLA Stevens and Weedon emend. Jenkins and Limber

Stroma developing within the host and erumpent, producing a superficial more or less irregular excrescence, with undifferentiated surface, exterior red to purple, external as well as internal stroma produced, light colored to olivaceous; asci at different levels, separated by pseudoparenchyma; spores muriform, hyaline.

Type: *Myrianginella tapirae* Stevens and Weedon (Mycologia **15**: 197. 1926).

Myrianginella sabaleos (Weedon) comb. nov., emend. Jenkins and Limber

Myriangium sabaleos Weedon, Mycologia **18**: 218. 1926.

Illustration: (FIGS. 1 and 2); Limber and Jenkins, Mycologia **41**, figure 1, *E–G*.

Spots amphigenous, small and inconspicuous to indistinct or negligible, usually somewhat paler than the surrounding leaf tissue, 0.25–1 × 1.3–5 mm., with the longest diameter parallel with the leaf axis, on dry specimen slightly swollen as well as often with fine longitudinal wrinkles, leaf tissue above developing ascomata becoming uplifted and variously ruptured, forming the clypeus; clypeus yellowish like the surrounding host tissue, or darkening to brown or nearly black, this coloration sometimes extending to the adjacent host tissue; ascomata amphigenous, more often epiphyllous, intraepidermal or produced in the mesophyll, at maturity innate to erumpent-superficial, in the latter case protruding from the clypeus or becoming completely exposed with the falling away of the clypeus; erumpent stromata circular, elliptical, or verruciform, in area 225–750 × 200–500 μ, and 65–200 μ thick; internal stroma extending horizontally 300–1200 μ, internal stroma and superficial stroma when present together reaching 132–430 μ in thickness, red to purple, in section coloration seems to be concentrated in the peripheral region of the pseudoparenchymatous structure, with the internal part hyaline to olivaceous, the so-called double ascoma sometimes formed by dense hyphae connecting the base of one exposed ascoma to another on the opposite side of the leaf; asci ovate, solitary in the tissue, distributed practically without order throughout the stroma although they may be concentrated in the outer part; asci, ovate, 8-spored, 21–29 ×

17–23 μ; ascospores clavate, straight or curved, muriform, with 3 to 6 transverse septa and 2 to 4 longitudinal septa, 16–27 × 5–9 μ, mostly 18–22 × 6.5–7.5 μ, hyaline; conidial stage observed in small openings in the stromata both in those that have not yet produced asci and those in which asci are present; conidiophores crowded, tapering, often flexuous toward the apex, 4–5 × 1–1.5 μ, those observed also on the surface of the stroma longer, 10–13 × 0.8–1.7 μ, hyaline; conidia elliptical to narrowly ovoid or clavate, 1-celled, 3–5 × 1.5–2 μ.

Associated with the myriangiale in the type specimen and apparently involved in the original description in so far as superficial aspects are concerned, but strictly not in microscopic characters, is the dothideale, *Catacauma sabal* Chardon (1). Its distinct nature was probably overlooked because of its overmature condition.

Distribution and specimens examined:

Florida: On living leaves of *Sabal etonia* Swingle ex Nash, De Soto City, October 27, 1943, A. S. Rhoads. *Catacauma sabal* Chardon most abundant as well as noticeable on this same specimen. USM.[5]

On leaves of *Sabal palmetto* (Walt.) Lodd., St. Petersburg, February 15, 1923, A. G. Weedon (*type*). The myriangiale is comparatively rare on this specimen, and *Catacauma sabal* much more abundant. NY, UI, USM.

Georgia: On leaves of *Sabal minor* (Jacq.) Pers., Savannah, December 31, 1943, A. W. Blizzard *943*. Associated as well as the most abundant fungus, *Catacauma sabal*. H, USM.

On young leaves of *Sabal palmetto*, Richmond Hill, December 9, 1943, A. W. Blizzard *890*. H, USM.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE,
HOBOKEN, N. J., AND
BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING,
BELTSVILLE, MD.

[5] Explanation of symbols is as follows:

USM Mycological collections of the Bureau of Plant Industry, Soils, and Agricultural Engineering, Beltsville, Md.

NY New York Botanical Garden, New York 58, N. Y.

UI Herbarium, Department of Botany, University of Illinois, Urbana, Ill.

H Pathological Herbarium, Bureau of Entomology and Plant Quarantine, Hoboken, N. Y.

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10. **Weedon, A. G.** Some Florida fungi. Mycologia **18**: 218–223. 1926.

EXPLANATION OF FIGURES

FIG. 1. *Myrianginella sabalcos* on leaves of *Sabal*: *A*, surface view, showing up-tilted shield (*b*), and ascomata beneath (*a*), × 12. *B*, section of an erumpent ascoma (*a*), seated in the epidermis (*b*), × 370. *C*, group of ascospores. *D*, *a*, section of an ascoma seated in the mesophyll (*b*); *c*, asci, × 100. *E*, section showing a "double" ascoma (*a a*), erumpent on opposite sides of the leaf (*b b*), × 100. *A–C*, and *E*, on *S. etonia*, De Soto City, Florida, October 27, 1943, A. S. Rhoads. *D*, on *S. palmetto*, Richmond Hill, Georgia, December 9, 1943, A. W. Blizzard 890. Photographs by R. L. Taylor (A) and by Limber.

FIG. 2. Ascospores, *A*, an ascus, *B*, of *Myriangina mirabilis*. *C–F*, *Myrianginella sabalcos*: *C*, ascus; *D*, conidiophores and conidia frequently found in cavities in the stroma (*cf. F, b*); *E*, ascospores; *F*, diagrammatic representation of an ascoma, *a*, remnant of clypeus of host tissue, *b*, conidia-bearing cavity, *c*, host tissue beneath fructification. *A–E*, 4 mm. = 1 μ; *F*, 1 mm. = 7 μ. Drawings by Limber.

STUDIES ON THE MORPHOLOGY AND CYTOLOGY OF THIELAVIA BASICOLA ZOPF [1]

GEORGE BLANCHARD LUCAS [2]

(WITH 1 FIGURE)

Thielavia basicola was first described in 1876 by Zopf (**11**) who found the organism in roots of *Senecio elegans* and lupines (**12**). It has been observed often on tobacco roots in association with *Thielaviopsis basicola*, the causal organism of black root rot. The pathogenicity of *Thielavia basicola* upon tobacco has not been demonstrated. Johnson (**5**) in 1915 believed *Thielavia basicola* to be the perfect stage of *Thielaviopsis basicola*. He reported a host range of nearly 100 species for *Thielaviopsis basicola* and found perithecia of *Thielavia basicola* in abundance upon *Cucumis maxima, Robinia pseudoacacia, Cytisus scoparius, Nicotiana tabacum* and to a lesser extent on numerous other hosts. McCormick (**7**) in 1925 showed that the two fungi were not related. She reported the occurrence of *Thielavia basicola* on the roots of tobacco, pea, violet and *Antirrhinum*. McCormick also showed that an isolate from violet roots, while exhibiting a tendency to form perithecia when grown in pure culture, was stimulated to produce perithecia abundantly when grown either with *Thielaviopsis basicola* or certain other fungi or with extracts from cultures of these fungi. In 1930, Emmons (**1**) described a soil-inhabiting species of *Thielavia* which readily produced perithecia in culture and which he named *T. terricola*. This fungus had been isolated originally by Gilman and Abbott (**4**) from Iowa and Louisiana soils and had also been observed on decayed strawberry roots in North Carolina (**1**).

[1] Contribution from the Plant Pathology Section, Department of Botany, North Carolina Agricultural Experiment Station. Published with the approval of the Director as Paper No. 309 of the Journal Series.

[2] Research Assistant Professor of Plant Pathology, North Carolina State College.

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The present discussion is concerned mainly with the morphology and cytology of an isolate of *Thielavia* from tobacco roots. Another from Austrian winter pea [3] and one from soybean [4] were also studied, to determine if strains of the fungus exist. All cultures were grown on several different artificial media and compared with an isolate of *Thielavia terricola* kindly furnished by Dr. C. W. Emmons.

MATERIALS AND METHODS

Tobacco roots infected with *Thielaviopsis* were collected and examined with a dissecting microscope for perithecia of *Thielavia*. Roots containing perithecia were plated on Richards agar (**9**) minus sucrose. Sterile filter paper was used as a carbohydrate source instead of sucrose. The medium tested about pH 5 after autoclaving. The plates were incubated at approximately 37° C. The above method proved very successful in isolating *Thielavia* from tobacco roots.

Single ascospore isolations were made with a Chambers micromanipulator. The spores were germinated in Van Tieghem cells on potato agar and transferred to tubes of oatmeal agar.

The perithecia of *Thielavia* used for sectioning and staining were produced in pure culture by growing the tobacco isolates on oatmeal agar in Petri dishes. Blocks of agar from 5- to 10-day-old cultures containing the perithecia were fixed in weak Flemming's solution and imbedded in paraffin in the usual way. Sections were cut 6 μ thick, stained with a 0.25 per cent aqueous solution of crystal violet and destained with picric acid and clove oil, according to the procedure recommended by Sass (**10**). Perithecia were also crushed and the clusters of asci stained with aceto-carmine or aceto-orcein. While this method proved very satisfactory in studying the increase in size of the ascus, nuclear structures were not well differentiated.

MORPHOLOGICAL VARIATION IN CULTURE

Forty-eight single ascospore cultures of *Thielavia* from the Austrian winter pea isolate were grown on oatmeal agar in test

[3] Isolated by Mr. Arthur Kelman of North Carolina State College.
[4] Isolated by Dr. S. G. Lehman of North Carolina State College.

tubes. All these cultures except one produced an abundance of fertile perithecia in 7 to 14 days. The exceptional culture had fluffy white aerial mycelium but no perithecia. It did produce a few scattered bodies which resembled perithecia but these never produced ascospores. When this culture was grown in the same Petri dish with other single-ascospore cultures no detectable fusion or stimulation was evident.

Nineteen single-ascospore cultures were obtained from an isolate of *Thielavia* from tobacco roots. All cultures produced an abundance of perithecia containing ascospores. Many additional mass isolates were obtained from tobacco roots over an eighteen-month period. In all cases the isolates produced numerous perithecia when grown on oatmeal agar.

Isolates of *Thielavia* from Austrian winter pea, soybean, tobacco and the culture furnished by Dr. Emmons were grown on Richards agar minus sucrose plus filter paper and incubated at room temperature. Under these conditions at the end of 10 days all cultures produced numerous perithecia scattered over the surface of the filter paper. Very little aerial mycelium was evident. The perithecia contained mature ascospores. At the same time duplicate cultures of all four isolates were grown on Richards agar plus sucrose but with no filter paper. At the end of 10 days all cultures had abundant white aerial mycelium. However, only the isolate from soybean had produced a sufficient number of perithecia to make them visible to the unaided eye.

The average size of the perithecia produced by the different isolates on various substrates varied widely. For instance, the perithecia produced by the soybean isolate on Richards agar plus sucrose averaged 110.5 μ in diameter. Perithecia produced by the same isolate on Richards agar minus sucrose plus filter paper averaged 219.9 μ in diameter. Perithecia of *T. basicola* found in tobacco roots averaged 59.7 μ in diameter, while perithecia produced by the tobacco isolate on Richards agar minus sucrose plus filter paper at room temperature averaged 130.8 μ in diameter.

All four isolates of *Thielavia* were also grown on oatmeal agar at room temperature. At the end of two weeks fifty mature ascospores from each of the four isolates were measured. At the end of two months fifty mature perithecia were measured. These

measurements as well as those of several other investigators are shown in table I.

TABLE 1

PERITHECIAL AND ASCOSPORE MEASUREMENTS OF *Thielavia* ISOLATES AS GIVEN BY VARIOUS WORKERS

Worker	Source	Substrate	Diameter of perithecia in microns	Size of spores in microns	
				Length	Width
Peglion (8)	Tobacco	Tobacco roots	80–100	8–10	4–5
McCormick (7)	Violet, tobacco pea	Violet, tobacco pea roots	99, 72, 66	10–13	4.5–6.5
Emmons (1)	Soil	Corn meal agar	80–125	10–16	7–9
Lucas	Tobacco	Tobacco roots	59.7	9.8–13.1	4.3–5.4
Lucas	Tobacco	Oatmeal agar	152.7	11.4–16.3	6.5
Lucas	Soybean	Oatmeal agar	162.5	11.4–13.1	6.5–8.2
Lucas	Austrian winter pea	Oatmeal agar	167.6	11.4–16.3	6.5
Lucas	Emmons culture	Oatmeal agar	96.7	11.4–13.1	6.5

CYTOLOGY OF THE PERITHECIUM AND ASCUS

The development of the perithecium of *Thielavia terricola* has been described by Emmons (2). The perithecia of the isolates of *Thielavia* from tobacco studied herein grew essentially as he describes. A hyphal coil forms which is soon surrounded by numerous hyphae. The interior of the growing perithecium is filled with slender, delicate hyphae, some of which are ascogenous hyphae containing paired nuclei. In the young perithecium, asci are found in all stages of development from crozier formation to mature asci. Frequently several asci in various stages of development can be seen growing from one hypha (FIG. 1, *C*). The ascogenous hyphae measure less than 3 μ in diameter when the croziers form. By the time the ascus is almost full grown, nuclear fusion has occurred and the ascus is characterized by a large fusion nucleus (FIG. 1, *E*) with a conspicuous dark-staining nucleolus. This nucleolus is approximately twice the diameter of the nucleolus seen in the ascogenous hyphae. Forty-five fusion nucleoli were measured. They ranged from 1.0 to 1.7 μ in diameter. The fusion nuclei were quite large, the average diameter being 4 microns. More than 200 asci were observed just after fusion had occurred, or in prophase I, but in no instance were chromosomes seen which measured over 2.0 μ in length. At this

stage it was not possible to distinguish clearly the number of chromosomes.

The nuclear divisions in the ascus seemed to follow each other rapidly. Relatively few figures of the first (FIG. 1, *F*) and second

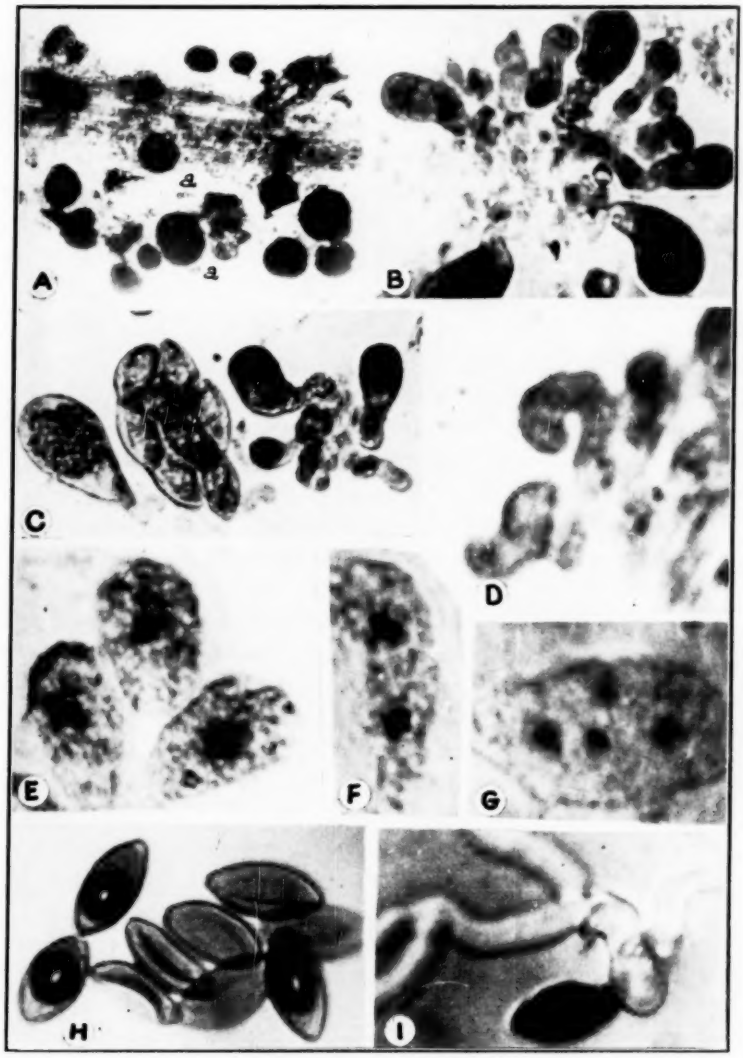

FIG. 1. *Thielaviopsis basicola.*

(FIG. 1, *G*) division were seen as compared to the fusion nucleus stages. However, several figures were seen in which the chromosome number could be determined as more than three and less than six. One figure of the second division was seen where five dot-like chromosomes were visible. None of these measured over 0.5 μ in length. The divisions appeared to occur along any plane of the ascus. After the third division the nuclei seemed to be located near the periphery of the ascus. Cleavage furrows appeared in the cytoplasm of the ascus as the ascospores were delimited. After the ascospores are mature the asci appear to deliquesce, leaving the ascospores free in the perithecium.

DISCUSSION

It is evident that *Thielavia basicola* is widespread in the soil. Zopf reported it from Germany, Peglion (**8**) from Italy. It has been found in Connecticut, North Carolina, Louisiana and Iowa.

McCormick (**7**) found that isolates of *Thielavia* were stimulated to produce many perithecia in culture when grown with several other fungi or extracts from these fungi. The isolate studied by Emmons (**1**) produced perithecia in culture without the presence of other fungi or fungous extracts. On this basis and because of the difference in ascospore size Emmons assigned a new specific name to the fungus studied by him.

The observations herein reported indicate that *Thielavia basicola*, though homothallic, is composed of various strains or forms. The isolate from soybean, for instance, produced numerous perithecia on Richards agar plus sucrose. The other isolates did not. Perithecia produced by the Emmons isolate were on the average much smaller than the perithecia produced by the other three isolates. Perithecia of *Thielavia basicola* as found in tobacco roots were on the average smaller than those produced in pure culture. This was also true of the ascospores. Thus, both size and production of perithecia and size of ascospores appear to be dependent on the source of the isolate and the substrate on which it is grown. It is doubtful, therefore, if presence or absence of perithecia in pure culture or minor differences in ascospore size can be used as valid measurements for delimiting two species in the strains stud-

ied. Very probably the isolate studied by Emmons should be included as a strain of *Thielavia basicola* and not given specific rank.

The association of *Thielavia basicola* and *Thielaviopsis basicola* is an interesting one. The author has observed *Thielavia* only on those tobacco roots which had been infected with *Thielaviopsis*. This has been observed by previous investigators (**3**) and led to the assumption that *Thielavia basicola* was the perfect stage of *Thielaviopsis basicola*. Attempts (**6**) to inoculate healthy tobacco roots with cultures of *Thielavia basicola* have not proved successful. Yet, perithecia of *Thielavia* have been observed in the cortex of roots attacked by *Thielaviopsis*. It may be that roots infected with *Thielaviopsis* are weakened or altered sufficiently to permit *Thielavia* to invade the tissues as a secondary organism.

SUMMARY

1. *Thielavia basicola* is widespread in the soil. The species is composed of forms or strains. The production and size of perithecia are dependent on the form isolated and the substrate on which it grows. Ascospores found in tobacco roots are not as large on the average as those produced in culture.

2. Isolates of *Thielavia basicola* were obtained from tobacco roots. Perithecia were produced in pure culture, sectioned and stained with crystal violet. Very young to mature asci were seen. Crozier formation occurred. The large fusion nucleus in each ascus contained a large nucleolus approximately twice the diameter of the nucleoli seen in the ascogenous hyphae. Three divisions occurred in the ascus. At prophase I the longest chromosome was not over 2 μ long. At the third division the chromosomes were 0.5 μ or less in length.

3. Four isolates of *Thielavia* from different sources were grown and compared in culture. Indications are that all four isolates should be included in the species *Thielavia basicola* Zopf.

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DESCRIPTION OF FIGURE

FIG. 1. *A*. Tobacco root affected with black root rot showing chlamydospores at *a* of *Thielaviopsis basicola* and perithecia of *Thielavia basicola* (approx. × 100). *B, C*. Developing asci (approx. × 900. *D*. Crozier formation (approx. × 1,800). *E*. Three asci each showing fusion nucleus with large nucleolus (approx. × 1,800). *F*. Ascus at first division two nuclei present (approx. × 1,800). *G*. Ascus at second division four nuclei present (approx. × 1,800). *H*. Mature ascospores (approx. × 900). *I*. Germinating ascospore (approx. × 900).

TWO UNUSUAL CONIDIAL FUNGI

FREDERICK A. WOLF

(WITH 5 FIGURES)

It occasionally happens, during the routine of collecting and identifying fungi, that a species having an unusual type of conidium and conidiophore is encountered. The two species given brief consideration herein are believed to be quite unlike any with which even well-trained and experienced students of fungi are acquainted, and consequently they are worthy of mention. One of them has been identified as *Cephaliophora tropica* Thaxter, and the other, as an hitherto undescribed species to which is given the name *Ypsilonia corticalis*.

CEPHALIOPHORA TROPICA

The genus *Cephaliophora* comprises two dung-inhabiting species, *C. tropica* and *C. irregularis*, the former being the type, both of which were described by Thaxter (**1903**). In the mycological literature available to the writer it is of more than passing interest that these species of *Cephaliophora* have never been recorded by other investigators.

C. tropica was isolated from materials sent from Jamaica, Java, Liberia, China, and the Philippine Islands. Presumably this species has a wide distribution in the tropics, and has been assumed to be restricted in range to the tropics. However, the isolates in hand appeared in cultures from inoculum obtained from decaying tobacco leaves which had long been in contact with the soil in a field at Oxford, N. C. On potato dextrose agar and other semi-solid media vegetative growth is profuse and fructifications are abundantly formed. The mycelium is loose, cottony, and septate. The conidiophores are erect, broadly-saccate, and have a short pedicel. Conidia are initiated as bud-like protrusions from the capitulum (FIG. 1). They extend outwardly in all directions and

are so abundant as eventually to conceal quite completely the capitulum, except its basal part and the pedicel (FIG. 3). Each conidiophore bears from 12 to 20 conidia, and all conidia are formed simultaneously. The conidia are broadly attached, ovoid

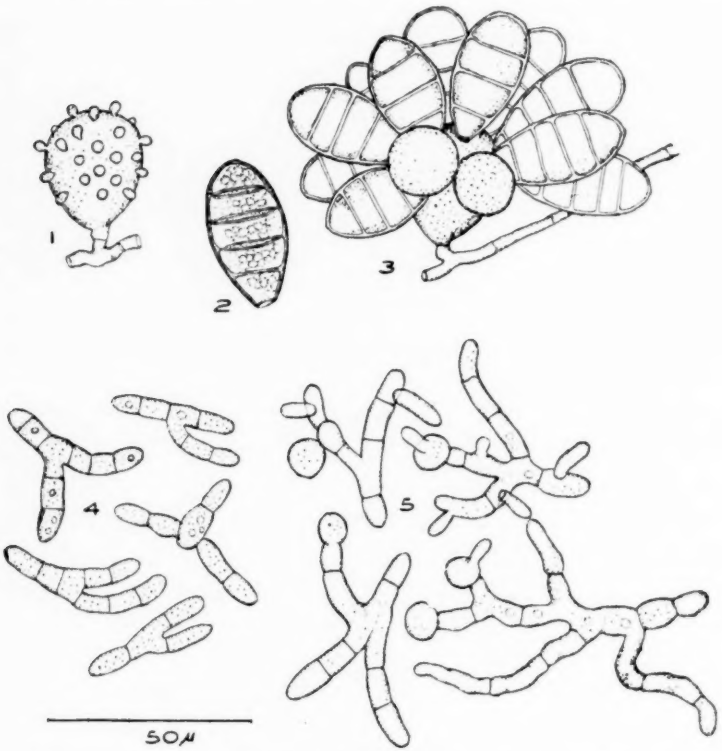

FIG. 1. Young conidiophore of *Cephaliophora tropica* bearing bud-like protrusions, the conidial initials.

FIG. 2. Mature conidium of *C. tropica*.

FIG. 3. Mature conidial fascicle of *C. tropica*.

FIG. 4. *Ypsilonia corticalis*, showing variations in shape of conidia.

FIG. 5. Germination of conidia of *Y. corticalis* in tap water, after 16 to 20 hours.

to elliptical, 3- to 5-septate, thick-walled, and yellow-brown (FIG. 2). Their average dimensions are $35 \times 16\,\mu$, but they may have an extreme length approximating $50\,\mu$.

The structural features of *C. tropica* show that it is among the Moniliales (Hyphomycetes), where it was assigned by Thaxter. It bears no marked resemblance, however, to *Oedocephalum* or other genera having capitate conidiophores. The conidia are not borne at the apices of small sterigmata, as occurs in *Oedocephalum*. Moreover the conidia of *C. tropica* are not thin-walled, as they are in other capitate hyphomycetes, but have an appearance not unlike that of conidia of *Helminthosporium*. In short, *Cephaliophora* is strikingly different and can be distinguished readily from all other capitate Moniliales.

Ypsilonia corticalis sp. nov.

Pycnidii 150–200 cr., sparsis, sphaericis, nigris, membraneis; contextu parenchymatico, conidiis ypsiliformibus, hyalinis, 3–5-septatis, 35–50 × 5–8 μ.

Hab. ad ramos emortuos *Quercus borealis*, socia *Lasiosphaeria pezizula*, in silvis, prope Durham, N. C., Amer. bor.

In *Ypsilonia* are included pycnidial fungi belonging to the Excipulaceae (Discellaceae) and possessing conidia resembling the shape of the Greek letter upsilon. Two species of *Ypsilonia* have been described previously, *Y. cuspidata* Lév. and *Y. vagans* Speg. Whether species of *Acanthothecium* and *Psalidosperma* should be regarded as members of *Ypsilonia*, as has been suggested, seems not to have been satisfactorily established.

The genus *Ypsilonia* was founded over one hundred years ago by Léveillé (**1846**), with *Y. cuspidata* as the type. This species was collected near Manila, P. I., where it occurred on the lower leaf surface of foliage of an unidentified member of the Anonaceae. *Y. vagans* was described by Spegazzini (**1908**). It occurred interspersed with *Zukalia vagans* Speg. (Perisporiales, Capnodiaceae) on the leaves of certain shrubs, including *Spiraea cantonensis* Lour., growing in the Botanical Garden at São Paulo, Brazil.

Ypsilonia corticalis occurs on the bark of oak slash in the Duke Forest. It is sparsely interspersed throughout patches of black turf, consisting of the conidiophores, and conidia, of *Helicoma curtisii* Beck., admixed with the perithecia of *Lasiosphaeria pezizula* (B. and C.) Sacc. Linder (**1929**) established the genetic

connection of this *Helicoma* and *Lasiosphaeria* by using cultures originating from ascospores.

The pycnidia are typically ypsiliform or bifurcate but the angle of divergence of the two branches may vary from acute to as wide as 180° (FIG. 4). They are hyaline, 3- to 7-septate, and measure 35–50 × 5–8 μ.

When placed in tap water or on maltose agar the conidia germinate readily (FIG. 5). The mycelial mat is adpressed, whitish, and lacks distinctive features. Conidia have not been observed to form in cultures.

Léveillé (**1846**) indicated that the conidia of *Y. cuspidata* lack septations but, because of the ratio of their length to width, it seems unlikely that mature conidia would remain non-septate.

The measurements of conidia of *Y. vagans* are 30–35 × 1 μ, and no mention is made of septation. In conidia so tenuous, septations would be difficultly discernible. In addition both conidia and conidiophores are ternate. Apparently the conidia arise from the apices of the ternate branches in *Y. vagans*, but from bifid branches in *Y. corticalis*.

Neither *Y. cuspidata* nor *Y. vagans* seems ever to have been collected more than once nor from any other than the type locality. The organism in hand is quite unlike either of these two species of Ypsilonia.

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Linder, D. H. A monograph of the helicosporous Fungi Imperfecti. Ann. Mo. Bot. Garden **16**: 227–388. 1929.

Spegazzini, C. Fungi aliquot Paulistani. Revista del Museo de La Plata **15**: 7–48. 1908. (Vide p. 35.)

STUDIES IN THE GENUS PLEOSPORA. I

LEWIS E. WEHMEYER

(WITH 17 FIGURES)

In a previous paper (**10**) an attempt was made to outline the course of evolutionary development within the genus *Pleospora*. The present paper is the first of several which will attempt to analyze more closely this situation; to group the collections studied into workable species, and attempt to find the proper binomials for these groups. The collections considered here are the simpler types which illustrate the origin of the main lines of development within the genus.

In the earlier paper mentioned it was shown that if a large number of collections having, for instance, a similar spore form were arranged according to spore size, a long series with overlapping spore measurements is obtained, often extending over the range of many described species. This same situation occurs as regards almost any pair of unit characters of spore form, size, septation, color, etc. Although there seem to be an infinite number of such combinations and variations, there is a certain correlation which allows a pattern of development to be discerned. Three such general lines of development, based on spore form and septation, were outlined, and for convenience in the following discussion the characters distinguishing each are briefly listed below.

Leptosphaeroid series:
- spores fusoid, strongly tapered at the ends;
- spores yellow-brown to dark yellow-brown;
- secondary septa laid down as transverse walls in the end cells; vertical septa tardily formed.

Vulgaris series:
- spores ellipsoid, ends tending to be more bluntly rounded;
- spores often inequilateral to curved;
- spores yellow-brown to red-brown;
- secondary septa laid down as both transverse and vertical walls, more or less simultaneously in the central cells, end cells normally without vertical septa.

Herbarum series:
spores oblong-ellipsoid, ends broadly rounded or bluntly tapered;
spores more often straight, either symmetric or asymmetric;
secondary septa as in vulgaris series but with additional, vertical, or "Y" shaped septa in the end cells;
spores yellow- to red-brown, more commonly red-brown.

The collections discussed in this paper are referred to by numbers, which are those of the writer's files. A list, in numerical order, with the data for each, is given at the end of the paper.

It should be definitely understood that the delimitation of species, from such a pattern as mentioned, is of necessity an arbitrary one and based upon personal judgment, but such a delimitation is necessary in order to have a basis for future revisions.

The basic spore form of the genus is a three-septate one. These first three septa are referred to as the primary septa. The origin of all the main lines of variation is foreshadowed within this group. The septation of the three-septate spore is, of necessity, leptosphaeroid, but the form and color changes of other series are found. *P. pellita* (FIG. 6) has the typical straight, tapered, sometimes asymmetric, yellow-brown spore of the leptosphaeroid series. *P. trichostoma* (FIG. 1) and *P. mollis* (FIG. 2) represent a small unrelated group, with oblong spores. In *P. oligostachyae* (FIG. 9) and *P. diaporthoides* (FIG. 10) the inequilateral or curved form of the spore is more pronounced and the ends are more bluntly tapered. These are tendencies leading to the vulgaris series. In the broader spores of this type vertical walls are occasionally seen in the end cells even in three-septate spores, indicating an early origin of this herbarum-series characteristic. It is in such broad spores [*i.e.*, *P. Boldoae* (FIG. 12), *P. lactucicola* (FIG. 13)] also in which the vulgaris type of septation of the central cells first appears. Certain species with three-septate spores also show tomentose or setose perithecia, and specimens on woody substrata show the elongate asci, uniseriate spores and large perithecia characteristic of this habitat.

PLEOSPORA TRICHOSTOMA AND P. MOLLIS

The first two species considered belong to an unrelated group which does not fit into any of the three series mentioned because

of the cylindric-ellipsoid spores with almost straight side walls and rounded ends. *P. trichostoma* has large light colored ascospores and large stromatic perithecia which are often setose. It is fairly common on stems of grasses. *P. mollis* which has smaller dark red-brown spores and small perithecia is based on a single collection, on *Ephedra*, from the Andes.

PLEOSPORA TRICHOSTOMA (Fr.) Ces. & de Not. Schema sfer. ital. 217. 1861.

Sphaeria relicina Fr. Syst. Myc. **2**: 505. 1823.
Sphaeria trichostoma Fr. Syst. Myc. **2**: 504. 1823.
Sphaeria polytricha Wallr. Fl. Crypt. Germ. 794. 1833?.
Pyrenophora trichostoma (Fr.) Fck. Symb. Myc. 215. 1870.
Pleospora relicina (Fr.) Wint. in Rab., Krypt. Fl. **1** (2): 520. 1887.
Pleospora polytricha (Wallr.) Tul. Sel. Fung. Carp. **2**: 268. 1863.
Pyrenophora relicina (Fr.) Fck. Symb. Myc. 215. 1870.
Sphaeria culmorum Cke. Grev. **3**: 68. 1874.
Pleospora culmorum (Cke.) Sacc. Syll. Fung. **2**: 263. 1883.
Pleospora Bromi Died. Centralbl. f. Bakt. Abt. 2, **11**: 52. 1903.
Pleospora teres Died. *Ibid.* 1903.
Pleospora Tritici-repentis Died. *Ibid.* 1903.
Pleospora Avenae Died. *Ibid.* 1903.
Pleospora graminea Died. *Ibid.* 1903.
Pleospora trichostoma f. sp. *Bromi* (Died.) Noack Zeitschr. Pflanzenkr. **15**: 193. 1905.
Pleospora trichostoma f. sp. *Tritici-repentis* (Died.) Noack *Ibid.* 1905.
Pleospora trichostoma f. sp. *Hordei erecti* Noack *Ibid.* 1905.
Pyrenophora Teres (Died.) Drechsler Journ. Agr. Res. **24**: 656. 1923.
Pyrenophora Tritici-repentis (Died.) Drechsler *Ibid.* 667. 1923.
Pyrenophora Bromi (Died.) Drechsler *Ibid.* 672. 1923.

Illustration. Figure 1.

Perithecia 300–500(750) × 200–350 μ, sclerotioid, usually rather thickly scattered, somewhat flattened-spheric, strongly erumpent, often becoming superficial, ostiole indefinite or flattened-papillate,

with a few or many, shorter or longer, stiff, brown, septate, pointed setae about the ostiole or the upper portion of the perithecium (sometimes broken off or wanting), wall thick-stromatic, with an outer blackened layer 10–20 μ thick and an inner hyaline parenchymatic layer 50–100 μ thick.

Asci stout clavate, with a much thickened wall, especially at the apex, base claw-like, 160–210 × 35–50 μ, with some interthecial tissue.

Spores biseriate, oblong-ellipsoid, 3-septate, rather light olive-brown, ends broadly rounded, constricted at all septa, often with a vertical septum in one or two cells, 44–60 × 18–25 μ.

Collections: *449, 450, 451,* on *Poa, Secale* and *Triticum,* from Europe.

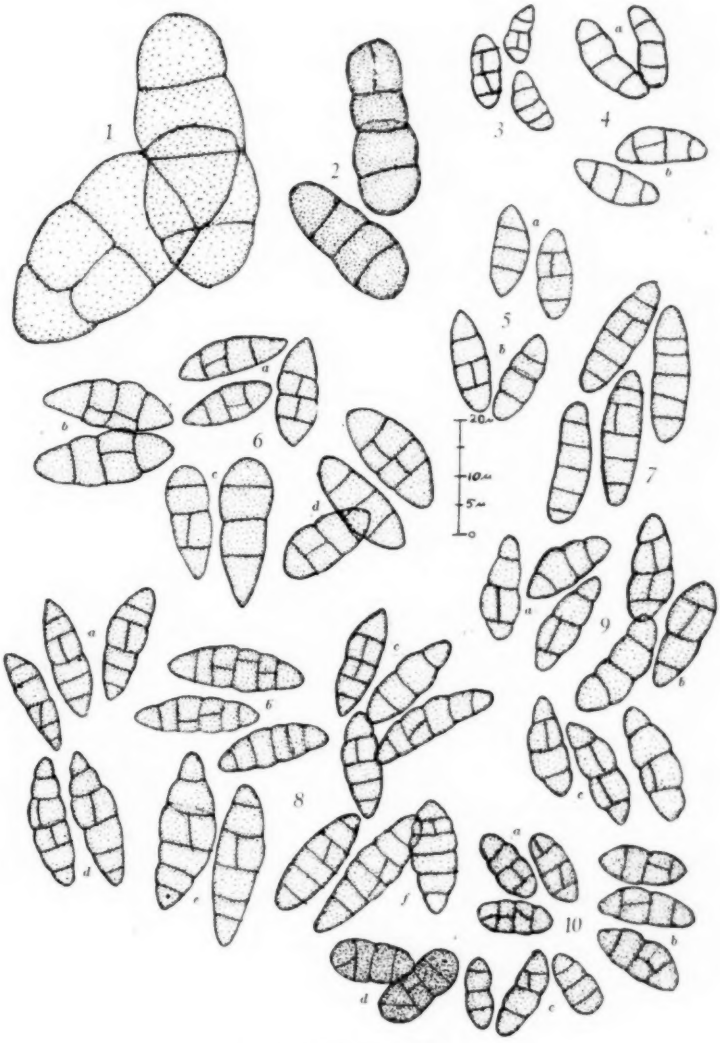
The collections grouped here represent a species complex which is very characteristic. It is found on the culms of grasses and has large sclerotioid perithecia with stiff apical spines. These spines are most abundant on sterile stromata and probably represent conidiophores which may bear the conidial stage, but may be broken off or be entirely lacking in some cases. The spores are characteristic, being large, oblong-ellipsoid and three-septate.

This species has been studied rather extensively by various plant pathologists. Diedicke (**3**) studied strains from different cereals and found conidial stages belonging to *Helminthosporium* spp., and differences in ability of different strains to infect different host genera. On perhaps incorrect evidence he excluded from *P. trichostoma* all races which produced such *Helminthosporium* stages and erected five new binomials (*Pleospora teres, P. Bromi, P. Tritici-repentis, P. Avenae* and *P. graminea*). These were to apply to the ascus stages of *Helminthosporium* species occurring on different host genera and were purely hypothetical in some cases. No specific descriptions were given. Noack (**7**) later considered these species as physiologic forms, which is a more logical treatment. Drechsler (**4**) recognized three of these species and transferred them to the genus *Pyrenophora* (*P. teres, P. Tritici-repentis,* and *P. Bromi*).

There is a great deal of variation in the size of the perithecium, ascus and ascospore within individual collections of this species group, and there may be some correlation between these characters

and the host occurrence, which would be a basis for varietal separation, but so far no such evidence has been seen.

The synonymy of the binomials given above is very much interlocked in the literature. These species all have the same large



FIGS. 1–10. Spores of *Pleospora*.

3-septate ascospores (see Berlese **1**, vol. *2*, *pl.* 51). Berlese (**1**, vol. *2*: 34) also gives *Pleospora sarcocystis* (B. & C.) Sacc. as a synonym. He distinguishes *Pleospora culmorum* (Cke.) Sacc. only on the lack of setae, which is not dependable. His figures of *Pleospora typhicola* (Cke.) Sacc. (**1**, vol. *2*, *pl.* 9, *fig.* 2) show vertical septa occurring more commonly in the end cells of the spores, but otherwise it is very similar to *P. culmorum*.

PLEOSPORA MOLLIS Starb., Arkiv. f. Bot. **5**: 24. 1905.

Illustration. Figure 2.

Perithecia small, 100–150 μ in diameter, somewhat flattened-spheric, thickly scattered in small seriate groups, immersed in the stem and erumpent in seriate lines of small longitudinal ruptures of the epidermis; wall 10–30 μ in thickness, of dark black, coarse parenchyma.

Asci few, stout-saccate, expanding rapidly when freed due to a gelatinous substance about the spores, and soon disappearing, 35–70 × 18–26 μ.

Spores 2- to 3-seriate, oblong, cylindric, dark red-brown, 3-septate, straight, ends bluntly rounded or with a slight taper, becoming constricted at the septa at maturity, vertical walls appearing in one or sometimes two cells (either central or end cells), 23–26.5 × 7–9 μ.

Collection: *35*, on *Ephedra*, from the Argentine Andes (*Type*).

This species is unique in the possession of dark, red-brown, 3-septate, cylindric spores (FIG. 2).

PLEOSPHAERIA HYPHASMATIS AND PYRENOPHORA DELICATULA

These two species would be excluded by many from the genus *Pleospora* because of the superficial position of the perithecia. They show, however, a primitive type and the origin of the dictyospore from the phragmospore type, for it is sometimes difficult to find spores with a vertical septum in any of their cells. In the tomentose or setose character of the perithecium they are similar to *Pleospora calvescens*.

PLEOSPHAERIA HYPHASMATIS (E. & E.) Berl., Icon. Fung. **2**: 63. 1900.

Pyrenophora hyphasmatis E. & E. Journ. Myc. **4**: 77. 1888.

Illustration. Figure 3.

Perithecia scattered, superficial, 250–400 μ in diameter, globose, with a conic to cylindric, prominent ostiole, covered with a tomentum of fine, soft, matted, somewhat septate, brown hairs, often collapsing in age.

Asci clavate, becoming more elongate at maturity, 60–80 × 8–9 μ, base claw-like, imbedded in an agglutinate mass of interthecial tissue.

Spores, biseriate, becoming overlapping uniseriate, broadly fusoid-ellipsoid, 3-septate, yellow-brown, straight or inequilateral, mostly symmetric, slightly constricted at the septa, ends acute or slightly rounded, often with a vertical septum in one of the central cells, 9–12.5 × 5.5–6.5 μ.

Collection: *1 (Type)*, on piece of rag, Louisiana.

This species may be considered as one of the most primitive of the genus. The spores (FIG. 3) are small, 3-septate and show vertical septa in less than fifty per cent of the individual spores. The perithecia are superficial and densely tomentose, but not setose. It also illustrates nicely the convergence of many described genera. Many such collections with only a few spores showing vertical septa have no doubt been described under *Leptosphaeria*. Because of the hairy perithecia it might be found in *Pocosphaeria*, or because of their superficial position, under *Venturiella*. Because of the vertical septa and hairy perithecia, Ellis placed the collection in *Pyrenophora*, even though it is not setose. Because of the superficial position, Berlese placed it in *Pleosphaeria*. If one disregards the hairiness as a generic character, it would fall in *Teichospora*.

PYRENOPHORA DELICATULA Vestergr., Jahreskatalog d. Wien. Krypt. Tauschanstalt **1897**: 3.

Illustration. Figure 4.

Perithecia minute, 70–100(150) μ in diameter, imbedded in the dense tomentum of the leaves, globose to conic; ostiole conic, surrounded by a fascicle of short, stout, stiff, pointed, brown, spine-like hairs 15–30(60) × 3–3.5 μ; wall thin membranous.

Asci clavate, wall only slightly thickened, 47–55(70) × 12.5–14 μ.

Spores biseriate, fusoid-ellipsoid with ends somewhat rounded, 3-septate, pale yellow-brown, inequilateral, one side flattened, or

somewhat allantoid, not constricted or very slightly so, most spores without vertical septa, but some spores with vertical septa in one or two central cells, 14.5–18 × 6–7 μ.

Collections: *2 (Cotypes), 60;* on *Cerastium*, from Sweden.

These perithecia have a definite fascicle of setae about the ostiole as given for *Pyrenophora*. They are imbedded in the leaf hairs, but are actually superficial. The spores (FIG. 4) are larger and more curved that in *P. hyphasmatis*. It might again be placed in *Pleosphaeria*. *P. calvescens* (FIG. 5) differs in the straighter spores and the larger immersed perithecia which are both tomentose and setose.

PLEOSPORA CALVESCENS AND P. PELLITA

There is some confusion in the literature concerning these two binomials. The spores are very similar, being 3-septate with occasional vertical septa in the central cells (FIGS. 5, 6), but two distinct species groups are discernible. The descriptions of Tulasne as well as most subsequent usage place *P. calvescens* as a form having perithecia with both a dense tomentum and stiff setose hairs and occurring on *Atriplex*, *Chenopodium*, etc. The spores of this species tend to be slightly inequilateral and somewhat smaller than those of *P. pellita* which has perithecia which are smooth or with a few soft hairs (conidiophores) and occurs mostly on *Papaver*. Berlese (**1**, vol. *2*: 6) unites these two species, but his *Pyr. echinella* (**1**, vol. *2*: 33) is probably the true *P. calvescens*.

PLEOSPORA CALVESCENS (Fr.) Tul., Sel. Fung. Carp. **2**: 266. 1863.

Sphaeria calvescens Fr. in Scler. Suec. 401.
Sphaeria Dematium (Pers.) Klotzsch in Herb. Myc. 154. 1832.
Cucurbitaria calvescens (Fr.) de Not. Schema Sfer. ital. 215. 1861.
Pyrenophora calvescens (Fr.) Sacc. Syll. Fung. **2**: 279. 1883.

Illustration. Figure 5.

Perithecia 200–300 μ in diameter, globose to somewhat depressed or flattened, thickly scattered or crowded, soon erumpent,

covered with a velvety tomentum of stiff brown hyphae which become straight, erect and setose on the upper surface of the perithecium, 50–100 × 5–7 μ. Perithecia stromatic, walls 20–30 μ thick, of dark brown parenchyma.

Asci cylindric-clavate, with thickened apical walls and claw-like base, 70–95 × 8.5–12 μ, imbedded in a rather abundant interthecial tissue.

Spores biseriate to overlapping uniseriate, fusoid-ellipsoid, yellow-brown, 3-septate, with pointed to slightly rounded ends, symmetric but often somewhat inequilateral, vertical walls in one or two of the central cells in a small per cent of the spores, 12.5–19 × 5.5–7 μ.

Collections: *3, 4, 5;* on *Atriplex* and *Chenopodium*, Germany.

Both de Notaris and Tulasne base their species on Fries, Scler. Suec. No. 401, which has not been seen, but Tulasne's description and most collections show the tomentose-setose perithecia which are characteristic. These stiff hairs may fall off or be worn away, and then the perithecia appear smooth and shiny.

PLEOSPORA PELLITA (Fr.) Rab., in Herb. Myc. II, No. 749. 1858.

Sphaeria pellita Fr. Syst. Myc. **2**: 502. 1823.
Sphaeria Papaveris Tul. Sel. Fung. Carp. **1**: 45 & *227*. 1861.
Cucurbitaria papaveracea de Not. Sfer. ital. 62. 1863.
Pyrenophora pellita (Fr.) Sacc. Syll. Fung. **2**: 280. 1883.
Pleospora papaveracea (de Not.) Sacc. Syll. Fung. **2**: 243. 1883.

Illustration. Figure 6.

Perithecia 200–300(400) μ in diameter, globose or somewhat flattened, sometimes collapsing, thickly scattered, or grouped in small seriate clusters which are erumpent through a longitudinal slit in the epidermis; walls rather thick, 20–30(50) μ, parenchymatic, often lighter colored below; smooth or with a few scattered setose conidiophores which soon break off, leaving short stubs.

Asci clavate to cylindric-clavate, wall somewhat thickened, base claw-like, 70–105 × (8.5)10–14 μ, imbedded in rather numerous interthecial strips.

Spores biseriate to overlapping uniseriate, fusoid or slightly clavate, pale yellow-brown to yellow-brown, 3-septate, usually straight, or slightly inequilateral, symmetric or often asymmetric with a longer more tapered lower portion, somewhat constricted

at the septa, with vertical septa in one or two central cells in most spores, ends rather acutely tapered, (14)16–21(26) × 6–8 μ.

Collections: *7, 9, 10, 11, 12, 13, 14, 120a, 352, 424,* on *Papaver, Salsola,* and *Bardana,* from Central Europe and Italy, and N. Dakota in the United States.

Cesati and Notaris (**2**, p. 218) and Tulasne (**8**, vol. *2*: 268) both cite Rab. Herb. Myc., Ed. II, 749 (No. *12*) as a basis of this species. This exsiccatus is typical of *P. pellita* as given above, showing the stubs of conidiophores, which have been broken off, on the perithecia. Tulasne comments that the *Sphaeria pellita* of Fries may not be the same fungus.

This species may be considered as a starting point for the series with smooth perithecia. The spores (FIG. 6) are more commonly found with vertical septa than in the species with hairy or setose perithecia just described, and they are usually straight (not inequilateral), but show a tendency to be more or less elongate and tapered below. The various collections (see table) show a good deal of variation in size but not enough for further separations. Most of the collections are on *Papaver,* and *Pleospora papaveracea* is probably a synonym.

No. *424,* of *P. Bardanae* Niessl (FIG. 6b), on *Althaea,* has large asymmetric spores, but No. *14* (FIG. 6c), on *Papaver,* has even more clavate spores of about the same size. Niessl's (**6**: 178) description of *P. Bardanae* agrees well with *P. pellita* except that he gives the spores as rounded above, tapered below and inequilateral or curved, which suggests the complex of collections placed in *P. diaporthoides.* Berlese (**1**, vol. 2, *pl.* 6, *fig.* 1) figures spores for *P. Bardanae* which are similar to those of *P. pellita,* but, again, slightly curved.

There are two fungi on collection No. *120,* of *P. Lecanora* Fabre, on *Salsola* from N. America. No. *120a* (FIG. 6d), with 3-septate spores, most resembles Fabre's description. These spores are shorter, broader and with more rounded ends than those typical of *P. pellita.* Vertical septa are very rare in these spores. This single collection of rather sparse material is not sufficient for a description, however, and other collections are needed. These spores have the form of those of *P. diaporthoides,* but are longer, and a paler yellow-brown.

THE PLEOSPORA VAGANS COMPLEX

P. calvescens and *P. pellita* have the simplest type of leptosphaeroid spores. The following species, *P. vagans*, as here conceived, includes a rather compact group of collections occurring on grasses, and has spores which can be derived from the *P. pellita* type by the insertion of an additional transverse septum in each of the end cells, giving a five-septate spore.

TABLE*

Coll. No.	Host	Spores	Asci	Perithecia
		Pleospora trichostoma (Fr.) Ces. & De Not.		
450	*Poa*	44–46×18–20	180–210×40–45	350–400, S, D
449	*Secale*	44–53×18–21	175–200×35–44	400–500, S, D
451	*Triticum*	44–60×18–25	160–200×40–50	300–400, D
		Pleospora calvescens (Fr.) Tul.		
3	*Chenopodium*	12.5–16×5.5–7	78–95×8–9	200–250, S, T
4	*Atriplex*	13–16×5.5–6.5	70–78×8.5–10	200–300, S, T
5	*Chenopodium*	13.5–19×5.5–6.5	75–85×10–13	200–300, S, T
		Pleospora pellita (Fr.) Rab.		
7	*Papaver*	14–19×6–7	78–90×10–12	200–300
352	*Papaver*	16–18×6–7	70–78×12.5–14	250–300
10	*Papaver*	16–19.5×6–7	75–95×10–12	250–350, c
9	*Papaver*	16–19.5×6–7		200–250
11	*Papaver*	16–20×6–7	78–90×11–13	200–250, D, C
120a	*Salsola*	17–21×7.5–8	85–110×12.5–14	200–300, D, C
14	*Papaver*	17–23×6–7		200–300, S
12	Herb	18–21×6–7	78–95×8.5–11	200–300, d, c
13	*Papaver*	18–21.5×6–7.5	78–95×8.5–11	300–400
424	*Bardana*	20–26×7–8	88–106×12.5–13	250–300
		Pleospora vagans Niessl		
23	*Clematis*	16–23×5.5–7	85–105×10–12	300–400
24	*Aira*	17–21.5×5.5–7	60–75×10.5–12.5	200–300, D
339	*Poa*	18–21.5×6–7	60–70×14–16	150–200, d
25	*Phleum*	18–22×5.5–6	60–65×13–15	150–250, d
26	*Phleum*	18–23×6–7	65–70×14–15	150–200
27	*Poa*	18–23×6–7	60–70×12–13	150–200
332	*Poa*	19–21.5×6–7	60–70×14	150–200
28	*Melica*	19.5–22.5×6–7	62–70×16–17	150–300, D
29	*Melica*	19.5–23×7	70–78×16–18	150–250
30	*Festuca*	20–23.5×7–8	70–90×17–18	250–350, d
335	*Agrostis*	20–25×8–9	70–78×19–21	300, D
324	*Calamagrostis*	21.5–23×7.5–8.5	60–80×14–17	250–350, D
325	*Elymus*	21.5–26.5×8.5–9.5	70–80×17–19	200–250, D
32	*Poa*	22–26×6–7	80–85×16–18	150–200
329	*Calamagrostis*	23–25×7–8	70–75×15–16	250–350
34	*Festuca*	23–26 (30)×8.5–9	70–90×14–18	200–250, D

* This table gives data for the individual collections. The letters T, S, D, and C stand for tomentose, setose, depressed and collapsing, respectively. Small letters indicate a lesser degree of the same condition.

PLEOSPORA VAGANS Niessl, Verhandl. naturf. Ver. in Brünn **14**: 174. 1876.

Pleospora fuegiana Speg. Fung. Fueg. (Bol. Acad. Nac. Cienc. de Cordoba **11**: 135). 1887.

Pleospora Forsteri Speg. Fung. Fueg. *Ibid.*

Illustration. Figure 8.

Perithecia 150–350(400) μ, mostly flattened-spheric, immersed beneath the epidermis, appearing on the surface as thickly scattered, separately erumpent papillate ostioles, each often surrounded by a minute circular grayish spot where the perithecia show through the epidermis, at other times forming small seriate or confluent clusters, causing elongate ruptures of the epidermis; walls rather thin (5–15 μ) membranous, parenchymatic, smooth.

Asci clavate, walls somewhat thickened, especially at the apex, base claw-like, 60–90 × 11–18(21) μ.

Spores biseriate, fusoid, yellow-brown to dark yellow-brown, 5-septate, straight, inequilateral or slightly curved, symmetric or slightly asymmetric due to the slight inflation of the third cell, vertical walls appearing in one or two central cells, slightly constricted or not constricted at the septa, the two central cells usually slightly larger than the other cells, end tapered, 17–26(30) × 5.5–9 μ.

Collections: *23, 24, 25, 26, 27, 28, 29, 30, 32, 34, 324, 325, 329, 332, 335, 339,* on various grasses, from Scandinavia and Tierra del Fuego.

Var. PUSILLA Niessl: l.c.

As described above except spores rather narrow, more tapered at the ends and more constricted at the septa, 17–23(26) × 5.5–7(8) μ.

Collections: *24, 25, 26, 27, 28, 29, 30, 32, 329, 332, 339.*

Var. ARENARIA Niessl: l.c.

As in the typical variety but spores larger, particularly broader, less strongly tapered, and less strongly or not at all constricted at the septa, 20–26(30) × 7.5–9.5 μ.

Collections: *34, 324, 325, 335.*

This group of collections on grasses forms a rather distinct species, which is no doubt the *Pleospora vagans* of Niessl. Most of the collections seen have come from Northern Europe, but it is

interesting to see several Spegazzini specimens from the southern tip of South America with almost identical characters.

Niessl described three varieties as follows:

a. *arenaria:* with perithecia on discolored spots, 250–270 μ; asci 105–120 × 21–23 μ and spores straight, clavate-fusoid, 27–30 × 9–10 μ. The elongate asci suggest *P. findens,* but the broad clavate spores do not; it is probably merely a well-matured condition in which the asci are stretching for ejection of spores.

b. *pusilla:* with perithecia small, 150–180 μ, not in discolored spots; asci 60–80 × 18–20 μ; spores 22–24 × 8–9 μ, with third cell swollen.

c. *Airae:* with clustered or seriate perithecia 220–250 μ in diameter; asci 75–90 × 16–18 μ and spores 21–26 × 8 μ.

There is some variation within the species (see table). There is one group of collections which seem to have broader, less strongly tapered spores, with slighter constrictions. These are placed in the variety *arenaria.* Niessl's variety *pusilla* is most typical of the species and is retained for the narrower spore type. Intergrades are, of course, found between these two varieties.

Berlese (**1**, vol. 2: 9) gives the spores of the variety *pusilla* as larger than those of *Airae,* but his figures (**1**, vol. 2, *pl.* 11, *figs.* 2 & 3) are both typical of the species as here described. His figures of spores (**1**, vol. 2, *pl.* 12, *fig.* 1) of the var. *Sparganii* Cke. are broader and characteristic of the var. *arenaria,* as here delimited. Berlese's figures (**1**, vol. 2, *pl.* 12, *figs.* 2 & 3) of *P. donacina* Niessl and *P. microspora* Niessl are also similar to this species, but Niessl gives the former as having larger, thick-walled, greenish spores, often with several vertical septa in each cell, and the latter as 3- sometimes 5-septate. Berlese's measurements for the spores of *P. microspora* are only 18 × 8 μ.

The type of *Pleospora fuegiana* Speg. (*32*) shows scattered small (150–200 μ) perithecia in the leaf tissue of *Poa Forsteri* erumpent as minute ostioles. The asci are clavate and 80–85 × 16–18 μ. The spores (FIG. 8d) are typical, in form, of the species, and 22–26 × 6–7 μ. They are rather long, but have the narrow tapered form of the var. *pusilla.*

The type collection of *Pleospora Forsteri* Speg. (*34*) shows the somewhat elongate type of pustule on stems of *Festuca magel-*

lanica. The perithecia are flattened and 200–250 × 100–150 μ. The asci are 70–90 × 14–18 μ and the spores (FIG. 8e) are 23–26(30) × 8–9.5 μ. The material is rather poor, but it fits Spegazzini's description and the broad spores are characteristic of the variety *arenaria*.

The spores of *P. vagans* differ from those of *P. pellita* not only in the addition of an extra septum, but also in the more symmetric but somewhat inequilateral form. The insertion of the extra transverse septa in the end cells causes the two central cells to be somewhat larger and the upper (third) cell is often somewhat swollen, as is commonly found in spores of *Leptosphaeria*. Collection *23*, of *P. parvula*, is one of those difficult ones which is intermediate between several species. Some perithecia show mostly 3-septate spores, others show many spores with one or two secondary septa laid down in the end cells giving 4- or 5-septate spores, whereas others show mostly 5-septate spores. These spores (FIG. 8c) are transitional between *P. pellita*, *P. vagans* and those with asymmetrical septation. The perithecia of this collection have the thick stromatic walls of *P. pellita* but the spores are larger and more like *P. vagans*. It is collections such as this that suggest that hybridization or perhaps heterokaryosis may occur and give rise to spores of two similar types. Such collections must be placed in a purely arbitrary fashion, as this one is in *P. vagans*.

The spores of *P. parvula*, as figured by Berlese (**1**, vol. 2: 5; *pl.* 5, *fig.* 1), suggest the shorter, stouter spores of *P. calvescens*. The long, narrow, cylindric asci and large perithecia of this collection are also correlated with its occurrence on woody stems, and it may eventually have to be segregated as a separate species.

PLEOSPORA FINDENS E. & E., Amer. Nat. **31**: 342. 1897.

Illustration. Figure 7.

Perithecia 350–400 μ in diameter, globose, rather deeply seated in the culm and erumpent as separate or somewhat linear clusters of conic ostioles; wall 10–20 μ thick, of rather dense, black-brown, parenchyma.

Asci long-cylindric, apical wall slightly thickened, base claw-like, 140–160 × 10–12 μ, rather numerous, interspersed by numerous interthecial strips.

Spores uniseriate to overlapping, oblong-ellipsoid to almost cylindric, yellow-brown, 5-septate, mostly straight, symmetric, ends bluntly rounded, vertical walls rather uncommon but found in one or two of the central cells of a number of the spores, constrictions none or very slight, 21.5–24.5 × 6–7 μ.

Collections: *31 (Type)*, on *Andropogon*, from New Jersey.

The above description is taken from the type collection of *P. findens*. It differs from *P. vagans* in the straight spores which have more nearly parallel side walls and bluntly rounded ends, giving a more cylindric form. The asci are also longer and narrower, with uniseriate spores, and the perithecia are larger and contain more interthecial strips (pseudoparaphyses). In these latter characters it resembles the species of *Pleospora* on woody stems, and in fact the spores of this species are very similar to those of *P. atromaculans* on *Cornus* and might be derived from them by the addition of secondary septa in the end cells.

PLEOSPORA OLIGOSTACHYAE AND P. DIAPORTHOIDES

It is necessary to consider at this point a rather confusing group of collections, which show the changes in spore form and septation which lead to the vulgaris series at the 3-septate level. The spores of some of these collections are very similar to and difficult to distinguish from those of *P. pellita*. In some cases it is necessary to place collections in a purely arbitrary manner. The general difference of the spores of this group (FIGS. 9–13) is that they are somewhat broader in appearance due to the lesser taper toward the ends, and tend to be inequilateral or curved, but symmetric, rather than straight and asymmetric, as in the *pellita* type. The occasional appearance of secondary septa, of the *vulgaris* type, in the central cells (see **10**), in these collections, gives rise to spores typical of the vulgaris series. It has also been observed that vertical walls are not uncommonly found in the end cells of spores which are only 3-septate in some collections. Such septation indicates an early tendency toward the herbarum series.

The binomial *Pleospora oligostachyae* is used for the first species of this group. It is represented by several collections on grasses, which have spores similar to those of *P. pellita* but more inequilateral-ellipsoid in form.

PLEOSPORA OLIGOSTACHYAE E. & E., Amer. Nat. **31**: 342. 1897.

Illustration. Figure 9.

Perithecia 150–250(300) μ in diameter, thickly scattered, or sometimes seriately arranged, globose or slightly flattened, immersed in the culms, with small papillate erumpent ostioles; walls rather thin, 10–20 μ thick, of coarse, light brown parenchyma.

Asci clavate to cylindric-clavate, with a claw-like base and a somewhat thickened wall, 70–88 × 10–12.5 μ.

Spores biseriate, fusoid-ellipsoid, yellow-brown to dark yellow-brown, 3-septate, mostly somewhat inequilateral or slightly curved, constricted at the central septum, sometimes at the secondary septa, ends somewhat tapered but rather bluntly rounded, rarely somewhat asymmetric, usually with vertical septa in one or two of the central cells, never in the end cells, 16–20 × 5.5–7 μ.

Collections: *8*, *17* (*Type*), *61a*, on *Sporobolus*, *Bouteloa* and *Andropogon*, from Kansas.

The type collection of *P. oligostachyae* is typical of this group of collections on grasses. The spores (FIG. 9c) are perhaps closest to those of *P. pellita* of this intermediate 3-septate group of species between the leptosphaeroid and vulgaris series. They differ from those placed under the following species in being larger, more tapered and more inequilateral, and they never show vertical walls in the end cells. *Pleospora Andropogonis* Niessl may be this same fungus, but the asci (90–96 × 24–27 μ) and spores (18–21 × 10–12 μ), as given by Niessl, are definitely broader than in *P. oligostachyae*.

Pleospora hysterioides E. & E., Erythea **2**: 19. 1894. The type collection (*61*) of this species bears two fungi with muriform spores, which apparently were confused by Ellis. One of these is of the *Hysteriographium* type with elongate (300–600 × 60–100 μ) flat ascocarps with carbonaceous walls 10–18 μ thick, and with a longitudinal ostiolar slit. The ascospores of this fungus are clathrate, flattened, narrow ellipsoid, rather dark yellow-brown, 3-septate, with vertical septa in the two central cells in face view, but showing no vertical walls in edge view. They are 13–18 × 5.5–7.5 × 3.5–4.5 μ. This same fungus was apparently described by Ellis (**5**: 53) in 1900, as *Hysteriographium graminis* E. & E. Ellis' spore measurements (15–20 ×

7–10 × 5–8 μ), in both cases, were somewhat larger than those obtained by the writer. Ellis' description of the *Pleospora* indicates that he was referring to this fungus, which must therefore be the type. The proper binomial, therefore, is **Hysteriographium hysterioides** (E. & E.) comb. nov.

This species may belong in Petrak's genus *Pseudopleospora*, which is given as having elongate perithecia opening by a slit, but the spores of his *P. ruthenica* are given as pyriform and no mention is made of any clathrate character.

The second fungus (*61a*) on the type collection is a good *Pleospora* with globose perithecia and three-septate spores (9b) like those of *P. oligostachyae*.

Ellis saw both fungi but apparently thought they were the same, for on a second packet (*8*) containing a collection on *Sporobolus*, made five days later, he says, "Spec. with perithecia orbicular and opening above with a single round pore. Found with others having a longitudinal dehiscence." On the paper of the first packet he has drawings of the *Pleospora* spores, but on an enclosed slip there are drawings of the *Hysteriographium* spores.

The following species includes a somewhat more heterogeneous group of collections, on hosts other than grasses, and with somewhat smaller spores (FIG. 10) which are more rounded at the ends, not inequilateral, and often showing vertical septa in the end cells. These spores are more of the type of the vulgaris series or even the herbarum series.

PLEOSPORA DIAPORTHOIDES E. & E., Proc. Acad. Sci. Phila. **1890**: 238.

Pleospora cercicola Speg. Fung. Chil. 85. 1910.

Illustrations. Figures 10–11.

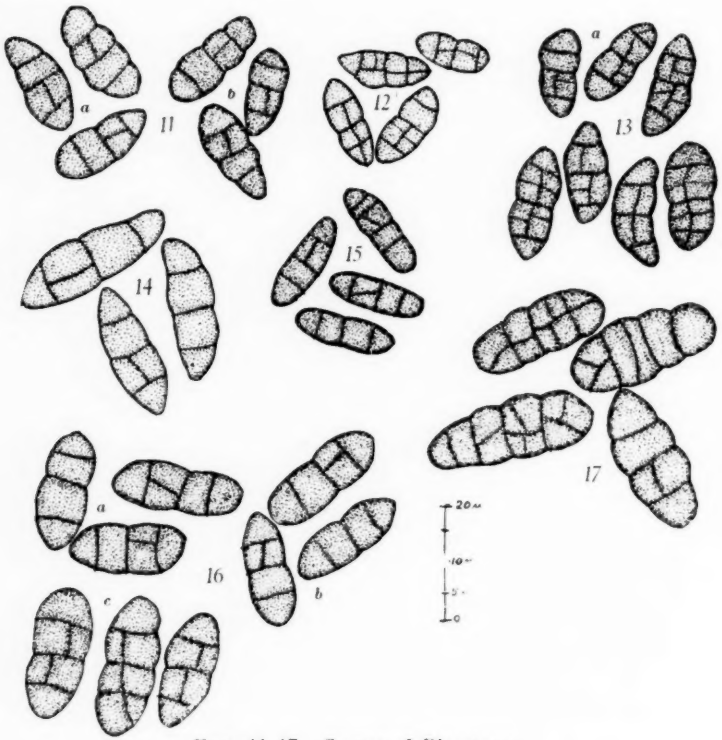
Perithecia 150–350 μ in diameter, scattered, globose, ostiole papillate, or somewhat elongate, walls 10–20 μ thick, parenchymatic.

Asci clavate to cylindric, base claw-like, wall somewhat thickened, 70–97 × 7–12.5 μ.

Spores biseriate to overlapping uniseriate, ellipsoid, yellow-brown to red-brown, 3-septate, mostly straight or very slightly

inequilateral, mostly symmetric or somewhat tapered below, ends mostly rather broad and blunt, occasionally tapered, vertical walls in one or both central cells and occasionally in the end cells (12.5)14–18 × (4.5)5.5–7 μ.

Collections: *6, 15 (Type), 423, 429,* on *Bardana, Pastinaca, Cereus* and *Tillandsia,* from California, New Jersey and Argentina.



FIGS. 11–17. Spores of *Pleospora.*

This is a rather heterogeneous group of collections, but they all show a common spore type which is straighter and with more blunt ends than in either *P. oligostachyae* or *P. pellita* (FIGS. 10, 11) and vertical walls occasionally appear in the end cells.

The type collection (*15*) of *P. diaporthoides* shows dark red-brown spores (FIG. 10b) which occasionally show faint secondary

septa of the *vulgaris* type in the central cells. A second collection (*16*) of this species, which has rather dark brown spores, shows such secondary septa in many of its spores and it is transferred to *P. lactucicola* E. & E. In the Riksmuseet, there is a packet (*6*) labelled *P. diaporthoides* E. & E., *Bardana*, N. J., but it also bears a pasted label "Pl.S.Calif. 5384, of *P. lactucicola* E. & E., on *Coleosanthus californicus*." The same collection appears under the same number in the New York Botanical Garden, with the comment "det. Rehm or *P. lactucicola* plus *Lophiostoma insidiosum*." The New York packet yielded nothing but a *Leptosphaeria*, but the one in the Riksmuseet bears a *Pleospora* with spores (FIG. 10a) as here described but rather small (12.5–14 × 5.5–6 μ) and yellow-brown.

The type collection of *Pleospora cercicola* Speg. (*423*) is very poor material, but it yielded a few perithecia with spores (FIG. 10d) of the *P. diaporthoides* type, dark brown and with occasional vertical septa in the end cells. It is placed here as a synonym for the present.

The type collection of *Leptosphaeria aerea* Speg. (*429*) yielded only a few perithecia with spores. Berlese (**1**, vol. 1 : 87) says this type collection is sterile. Many of these spores (FIG. 10c) showed vertical septa in some of the cells, and, in fact, Spegazzini shows such vertical septa in his figures on the packet. This should be a *Pleospora*. These spores are of the general type here considered, but are rather small (12.5–16 × 4.5–5.5 μ) and yellow-brown, in which respects they agree with (*6*). These two collections might be considered a variety or species, but too few collections are yet available for such a segregation. The spores of *L. aerea* are also more asymmetric and tapered below than the other collections of this group.

Two collections (Nos. *447* & *492*) recently examined from India, on *Zizyphus* and *Sueda*, show spores (FIG. 11) similar to those of this species, but somewhat broader and more rounded at the ends. The perithecia are also early and strongly erumpent, resembling a *Teichospora* at maturity. They approach *P. carpinicola*, on woody stems, and may represent a separate species if confirmed by more collections.

Pleospora clypeata sp. nov. (FIG. 14)

Peritheecia 300–500 μ diametro, aspectu superficiali sicut maculae rotundae, atrae, dispersae, in cortice immersa, dein erumpentia ut ostiola brevia cylindrica; pariete 50 μ crasso, ex parenchymate crasso, atro constituto; clypeo stromatico rotundato, 100 μ crasso praedita, ex contexto nigricanti subtem epidermidem hyalinam. Asci numerosi longe cylindrici, 140–160 × 11–14 μ, pariete crasso; basi unguiculiformes. Sporae 23–26 × 7.5–9.5 μ, imbricatae, uniseriatae, fusoideae, lutei-brunneae, 3-septatae, plerumque rectae et symmetricae, interdum inaequilaterales vel asymmetricae, acute angustatae, ad septa constricta, cellulis centralibus una vel duabus verticaliter septatae.

Specimen typicum in foliis *Agavis*, in Herbario Horti Botanici Noveboracensis, No. 21.

Perithecia 300–500 μ in diameter, appearing upon the surface as thickly scattered, black, circular spots, immersed in the cortex and erumpent through the cuticle as short cylindric ostioles; wall some 50 μ thick, composed of coarse black-walled parenchyma, commonly splitting into two layers. There is also a ring-like, clypeate, stromatic blackening of the tissues just beneath the cuticle (which remains hyaline) about 100 μ in thickness, which appears on the surface as a circular blackened spot.

Asci numerous, long-cylindric, with a thickened wall and a claw-like base, 140–160 × 11–14 μ, imbedded in numerous interthecial strips.

Spores overlapping uniseriate, fusoid, yellow-brown, 3-septate, mostly straight and symmetric or slightly inequilateral or asymmetric, acutely tapered toward the ends, slightly constricted at the central septum, usually one or sometimes two central cells with a vertical septum, 23–26 × 7.5–9.5 μ.

Collection: *21*, on *Agave* (*Type*).

This collection, in the New York Botanical Garden, bears no data, but is placed under *Pleospora Thuemeniana* Sacc. and is accompanied by a description. The spores have the same form as those of *P. pellita*, but are larger. The perithecia, however, are large, thick-walled and form a definite clypeus. This clypeus formation may be a reaction of the host, for other collections of *Pleospora* on *Yucca* and *Agave* show the same sort of clypeus but the perithecia contain quite different spores. The asci are also long and cylindric, with uniseriate spores and prominent interthecial strips, as found in species on woody substrata.

Portions of the type collection (*438*) of *P. Thuemeniana* Sacc., collected by Ravenel, on *Yucca aloifolia*, in 1876, have been ex-

amined in Thuem. Myc. Univ. 1846 (Riksmuseet), Roum. Fung. sel exs. 4959 (N.Y.B.G.) and the Sydow Herbarium (Riksmuseet). These all contain various Fungi Imperfecti but no *Pleospora* except for a few loose spores on the surface which might have belonged to *P. vulgaris*. The description gives the spores as three-septate and 18–20 × 7–8 μ.

Another collection in the N.Y.B.G. (*270*) on *Agave* shows identical perithecial development as in No. *21* but spores of the *P. media* type. Berlese, again, describes and figures spores (**1**, vol. *2*: 6, *pl.* 6, *fig.* 2) which he says were taken from Saccardo's original material. The figures show more ellipsoid spores with more rounded ends than those found in No. *21* and they are colored greenish, but the dependability of this color is questionable. These spores are 3-septate and 18–21 × 7–9 μ. He shows no clypeus about the perithecia, and gives them as 250 μ in diameter. No. *21* may be the same as *P. Thuemeniana*, but in the absence of any definite evidence from authentic material it seems better to describe it as new. Because of the clypeus this species might be placed in *Phaeopeltosphaeria* Berl. but these clypeate blackenings occur in fungi of many different types and the type of this genus (*P. caudata*) does not seem to be related to *Pleospora clypeata*.

The origin of secondary septa, of the vulgaris type, in the central cells of such spores as those of *P. oligostachyae* and *P. diaporthoides* gives rise to 5-septate spores of the type found in the vulgaris or herbarum series, in contrast to those of *P. vagans* in the leptosphaeroid group. This type of septation has no doubt arisen at various times in various strains and is found in varying percentages in the spores of different collections.

PLEOSPORA BOLDOAE AND P. LACTUCICOLA

Collections whose spores show the transition from the 3- to the 5-septate condition are also difficult to distinguish from immature collections of species (*i.e.*, *P. vulgaris*) whose spores are definitely 5-septate at maturity, for such immature spores show an irregular and progressive insertion of additional septa.

The following two species, therefore, are more or less arbitrary groupings of such transitional spore types.

PLEOSPORA BOLDOAE Speg., Fung. Chil. 87. 1910.

Illustration. Figure 12.

Perithecia 200–400 × 150–200 μ, somewhat flattened, formed beneath the periderm.

Asci cylindric-clavate, 70 × 12.5 μ, with a somewhat tapered base, and slightly thickened walls.

Spores biseriate, light yellow-brown, ellipsoid, 3-, sometimes 4- or 5-septate, straight or slightly inequilateral, mostly symmetric, ends bluntly tapered or broadly rounded, constricted at the central septum, sometimes at the secondary ones, either the central or end cells with vertical septa and often with secondary vulgaris-type transverse septa in one or, rarely, both central cells, 14–17 × 5.5–7 μ.

Collection: *22 (Type)*, on *Boldoa fragrans*, Chile.

The type collection of this species contains only a few perithecia in very poor condition. The spores are mostly 3-septate but may have an additional septum in either central cell and vertical septa in either the central or end cells. They differ from those of the following species in the light yellow-brown color.

PLEOSPORA LACTUCICOLA E. & E., Journ. Myc. **4**: 64. 1888.

Illustration. Figure 13.

Perithecia globose or somewhat flattened, 200–300 μ in diameter, thickly scattered, immersed, erumpent as small papillate ostioles; wall 10–20 μ thick, composed of small-celled, dark, thick-walled parenchyma.

Asci clavate, apical wall slightly thickened, base claw-like, 75–110 × 10–15 μ, with rather numerous filiform interthecial strips.

Spores biseriate, ellipsoid to fusoid-ellipsoid, reddish-brown, 3- to 5-septate, straight or inequilateral to slightly curved, mostly symmetric, ends bluntly tapered or rounded, constricted at the central septum, one or both central cells often with vulgaris-like secondary septa, vertical septa sometimes present in end cells, 15–20 × 5.5–7(8) μ.

Collections: *52 (Type)* and *16*, on *Lactuca* and *Artemisia*, from New Jersey.

Ellis says that his *P. lactucicola* differs from *P. Bardanae* Niessl in smaller perithecia (175–200 μ) and smaller darker spores. The spores are dark and red-brown, but the perithecia are up to

300 μ and the spores to 20 μ. Ellis does not mention the additional septa in the central cells, but they are shown by Berlese (**1**, vol. 2, *pl.* 4, *fig.* 2). Collection *16* was placed in *P. diaporthoides* by Ellis, from which species it differs only in the insertion of the additional septa in the central cells.

PLEOSPORA ATROMACULANS, P. SHEPHERDIAE AND P. AMELANCHIERIS

There are several species with 3-septate spores which show certain characters typical of the wood-inhabiting forms and should probably be considered as the beginning of these tendencies. *P. clypeata,* already described, on *Agave,* has perithecia which are large and thick-walled and the asci are long-cylindric and imbedded in prominent interthecial strips. In *Pleospora atromaculans* (FIG. 15) and *P. findens* (FIG. 7) the spores are oblong in form, intermediate between the leptosphaeroid and vulgaris type, but do not seem to be related to *P. trichostoma.* In *P. atromaculans* the spores are red-brown and so suggest the vulgaris series, *P. findens,* on the other hand, has pale yellow-brown spores which are 3-septate and differ from *P. vagans* only in their cylindric form. *P. Shepherdiae* (FIG. 16) and *P. Amelanchieris* (FIG. 17) have spores which are characteristic in form of the vulgaris series and grade off into that series by the insertion of secondary septa.

PLEOSPORA ATROMACULANS Rehm, Ann. Myc. **6**: 177. 1904.

Illustration. Figure 15.

Perithecia 300–400(500) μ in diameter, thickly scattered, imbedded in the cortex, erumpent through the periderm, causing blackened angular ruptures 250–500 μ in diameter; walls rather thick (30–50 μ), of flattened brown parenchyma.

Asci numerous, clavate to cylindric-clavate, walls only slightly thickened, base claw-like, 70–80 (100 μ in desc.) × 9–11 μ, imbedded in a mass of interthecial strips.

Spores biseriate to obliquely uniseriate, oblong-ellipsoid or almost cylindric, red-brown, 3-septate (rarely 5-septate), ends bluntly rounded, constriction none or slight at central septum, one vertical septum in one of the central cells of less than 50 per cent of the spores, 14–17 × 5–5.5 μ.

Collection: *18*, on *Cornus*, N. Carolina (*Type*).

This species shows the characteristics of the forms on woody substrata, but to only a slight degree. The perithecia are rather large and thick-walled and cause rather wide ruptures of the periderm. The asci are numerous, somewhat cylindric and with abundant interthecial strips, but these characters are not as outstanding as in other woody forms. The spores have a characteristic almost cylindric form, with straight side walls and rounded ends, in which they differ from those of *P. diaporthoides*. These spores are occasionally 4-septate, in which case the additional septum is laid down in the end cell.

PLEOSPORA SHEPHERDIAE Pk., Rep. N. Y. St. Mus. **40**: 71. 1887.

Pleospora carpinicola E. & E. Proc. Acad. Nat. Sci. Phila. **1893**: 135.

Karstenula carpinicola (E. & E.) Berl. Ic. Fung. **2**: 4. 1900.

Pleospora juglandis E. & E. Bull. Torr. Bot. Cl. **24**: 279. 1897.

Illustration. Figure 16.

Perithecia 250–700 μ in diameter, scattered or sometimes in small groups or confluent, globose or slightly flattened, sunken in the cortex, with small papillate ostioles erumpent through linear, angular or circular ruptures of the periderm; walls thick (30–100 μ), consisting of an outer layer of dark brown and an inner layer of hyaline parenchyma.

Asci numerous, long-cylindric, apical wall somewhat thickened, base claw-like, 85–180 × 7–11 μ, with numerous interthecial strips.

Spores uniseriate to overlapping uniseriate, oblong-ellipsoid or sometimes clavate, yellow-brown to light red-brown, 3-septate, ends broadly rounded, straight, symmetric or sometimes somewhat tapered below, one or two of the central cells with vertical septa in about half of the spores, rarely with a vertical septum in an end cell, 17.5–23 × 6–11 μ.

Collections: *164* (*Type*), *19*, *20*, on *Shepherdia*, *Carpinus*, and *Juglans* from Kansas, New York and Ontario.

The three species united here are all very similar; they might be considered as varieties, but until a greater number of collections

demonstrates the constancy of the minor variations it is considered more practical to unite them. They all show the large, thick-walled perithecia, with many cylindric asci imbedded in an abundance of interthecial stromatic tissue and characteristic of these woody forms.

The type (*164*) of *P. Shepherdiae* shows certain differences in the larger more flattened and more widely erumpent perithecia and the greater variability of the spores (FIG. 16a), which are often asymmetric, tapered below, or may occasionally show secondary septa, becoming 4–5-septate.

The type of *P. carpinicola* (*19*) shows smaller perithecia (250–500 μ) and rather small, narrow, regular spores (FIG. 16b), 18–21.5 × 6–7.5 μ. The perithecia are sometimes confluent, but never grouped in stromata, not tomentose, and not red or white as suggested by Berlese in transferring this species to *Karstenula*.

The type of *P. Juglandis* (*20*) has the smaller perithecia (300–400μ) and regular spores (FIG. 16c) of *P. carpinicola*, but the spores [19–23 × 7.5–9(11) μ] are larger and the asci (160–180 × 9–11 μ) longer.

The following species commonly shows secondary septa and therefore is of the 5-septate type. The spores show the transition to the vulgaris type of septation, bearing the same relationship to *P. Shepherdiae* that *P. lactucicola* bears to *P. diaporthoides*.

PLEOSPORA AMELANCHIERIS Wehm., Lloydia **9**: 206. 1946.

Teichospora praestipa Clem. ined. in Crypt. Form. Colo. 456.

Illustration. Figure 17.

Inasmuch as a description has been given of this species in a previous paper (**9**) it will not be repeated here. It differs from the preceding species in the large rimosely cracked and widely erumpent perithecia and in the larger spores (22–26 × 9–10.5 μ) which commonly show secondary septa of the vulgaris type in the central cells and sometimes vertical septa in the end cells. They are also more commonly constricted at the secondary septa.

Collection *165* (*Type*) and *166*, on *Amelanchier*, from Colorado and Wyoming.

COLLECTIONS CITED

1. *Pyrenophora hyphasmatis* E. & E., on rejected piece of rag, Pointe à la Hache, La., July 25, 1888, leg. A. B. Langlois (Fl. Ludoviciana No. 1434) (N.Y.B.G.) (*Type*). (Ellis cites the type as from St. Martinsville, La., July 1888, Langlois No. 1433, but this is no doubt the same coll.)
2. *Pyrenophora delicatula* Vestergr., on *Cerastium tomentosum*, Hort. Upsal., Suecica, May and June, 1896, Tycho Vestergren. *2* pkts. (*Cotypes*) (Riksmuseet).
3. *Pleospora calvescens* (Fr.) Tul., Syd. Myc. March. 661, on *Chenopodium album*, Berlin, July, 1884, P. Sydow (Riksmuseet).
4. *Pleospora calvescens* (Fr.) Tul., Rehm Asc. 439b, on *Atriplex nitens*, Elb-Ufer, bei Königstein (Sachsen), Aug., 1882, Kreiger (Riksmuseet).
5. *Pleospora calvescens* (Fr.) Tul., All. & Schnabl. Fung. Bav. 339, on *Chenopodium album*, München: Sendling, April, 1894, Schnabl. (Riksmuseet).
6. *Pleospora diaporthoides* E. & E., on *Bardana*, N. J. (Riksmuseet; Rehm Herb.). (There is also a label, *P. lactucicola* on *Coleosanthus californicus;* Pl. S. Cal. No. 5384, on this packet.)
7. *Pyrenophora pellita* (Fr.) Sacc., on *Papaver somniferum*, Fischerhaus bei Grossbehaltre, Kr. Westhavelland (?),* April 5, 1904, W. Kirschstein (Riksmuseet).
8. *Pleospora hysterioides* E. & E., on *Sporobolus asper*, Rockport, Kans., Feb. 15, 1893, Bartholomew No. 932 (N.Y.B.G.; Ellis coll.).
9. *Sphaeria pellita* Fr., on pavot somnifere, à la compagne de Mr Goethals—Delevigne près Courtrai (Riksmuseet, ex Herb. Syd., ex West. Herb. Cr. Belg. 652).
10. *Pleospora calvescens* (Fr.) Tul. f. *papaveracea* (DN.) Sacc., Rehm Asc. 736b, on *Papaver somniferum*, Mullrose (Brandenburg), 1909, P. Sydow (Riksmuseet).
11. *Pleospora pellita* (Fr.) Rab., Thuem. Herb. Myc. 356, on *Papaver somniferum*, Baden, bei Rastadt, Oct., 1875, leg. Schroeter (Riksmuseet).
12. *Pleospora pellita* (Fr.) Rab., Herb. Myc., II, 749, on herbaceous stem, Dresden, spring (Riksmuseet).
13. *Pleospora papaveracea* (de Not.) Sacc., Rehm Asc. 736, on *Papaver somniferum*, Ungarisch-Altenburg (Ungarn), April, 1883, Prof. Linhart (Riksmuseet).
14. *Pleospora pellita* (Fr.) Rab., on *Papaver Rhoes*, Neuchatel, May 22, 1871, leg. Morthier (Riksmuseet: Herb. Syd.).
15. *Pleospora diaporthoides* E. & E., on *Pastinaca sativa*, Newfield, N. J., July, 1890 (N.Y.B.G.: Ellis coll.) (*Type*).
16. *Pleospora diaporthoides* E. & E., on *Artemisia vulgaris*, Newfield, N. J., Aug. 20, 1896 (N.Y.B.G.: Ellis coll.).
17. *Pleospora oligostachyae* E. & E., on *Boutcloa oligostachya*, Rooks Co., Kans., Oct. 5, 1896, E. Bartholomew (N.Y.B.G.: Ellis coll. 2325) (*Type*).

18. *Pleospora atromaculans* Rehm, on *Cornus*, Blue Mts., N. Carolina, 1903, leg. Atkinson (Riksmuseet) (*Type*).
19. *Pleospora carpinicola* E. & E., on *Carpinus* (*americana*), London, Canada, April, 1892 (N.Y.B.G.: Ellis coll. No. 1738) (*Type*).
20. *Pleospora juglandis* E. & E., on *Juglans nigra*, Rooks Co., Kans., May 12, 1897, E. Bartholomew (N.Y.B.G.: Ellis Coll. No. 2405) (*Type*).
21. *Pleospora Thuemeniana* Sacc., on *Agave* (N.Y.B.G.: Ellis coll. No data, but description given).
22. *Pleospora Boldoae* Speg., on *Boldoa fragrans*, Talcahuana, Chile, Jan., 1909 (La Plata Mus. No. 2182) (*Type*).
23. *Pleospora parvula* Berl., on *Clematis* (Lovere im Treo-Min ??),* Italia, May, 1900, Dr. Rehm (Riksmuseet: Herb. Rehm).
24. *Pleospora minuta* Romell inedit., on *Aira caespitosa*, *Phleum pratense*, Nrk. par Kumla: Kumla, June 19, 1885, M. A. 23, leg. L. Romell (Riksmuseet Herb. Lars Romell No. 16114).
25. Undetermined, on *Phleum*, Gottland: Bro, July 18, 1913, T. Vestergren (Riksmuseet: Fung. Suec.).
26. Undetermined, on *Phleum pratense*, Gottland: Bro, July 17, 1913, leg. T. Vestergren (Riksmuseet: Fung. Suec.).
27. Undetermined, on *Poa pratense*, Gottland: Bro, July 17, 1913, leg. T. Vestergren (Riksmuseet: Fung. Suec.).
28. *P. tenuis* ined., on *Melica ciliata*, Gottland: Bro, July 19, 1920, leg. T. Vestergren (Riksmuseet: Fung. Suec.).
29. Undetermined, on *Melica ciliata*, Gottland: Brissund, June 22, 1920, leg. T. Vestergren (Riksmuseet: Fung. Suec.).
30. Undetermined, on *Festuca rubra*, Gottland: Bro, June 17, 1920, leg. T. Vestergren (Riksmuseet: Fung. Suec.).
31. *Pleospora findens* E. & E., on *Andropogon virginica*, Newfield, N. J., Oct. 28, 1896 (N.Y.B.G.) (*Type*).
32. *Pleospora fuegiana* Speg., on *Poa Forsteri*, Chair Is., Tierra del Fuego, May, 1882 (La Plata Mus. 2179) (*Type*).
34. *Pleospora Forsteri* Speg., on *Festuca magellanica*, Isle de la Estados, March, 1882 (La Plata Mus. 2188) (*Type*).
35. *Pleospora mollis* Starb., on *Ephedra americana*, Jujuy, Argentina, Morene, Dec. 16, 1901, R. E. Fries (Riksmuseet: Exp. Suec. Chaco-Andinis No. 230) (*Type*).
52. *Pleospora lactucicola* E. & E., on *Lactuca*, Newfield, N. J., June 9, 1878, leg. Ellis (N.Y.B.G. 3061: Ellis coll. 297).
60. *Pyrenophora delicatula* Vestergr., on *Cerastium tomentosum*, Hort. Upsal. Suecica, April 14, 1899, leg. Vestergren (Riksmuseet: Vest. Micr. rar. sel. 107).
61. *Pleospora hysterioides* E. & E., on *Andropogon nutans*, Feb. 10, 1893, Kansas, leg. Bartholomew (N.Y.B.G.: Ellis coll. 915) (*Type*).
61a. Same data; second fungus.
120. *Pleospora Lecanora* (Fabre) Rehm, on *Salsola Tragus*, Kulm, N. Dakota, July 19, 1913, leg. J. Brenckle (Riksmuseet: Rehm Herb. ex Brenckle Herb. Fung. Dak. 240).

* Question marks indicate that the handwriting on the packet could not be deciphered and the translation given is extremely doubtful.

120a. Same data; second fungus.

164. *Pleospora Shepherdiae* Pk., on *Shepherdia canadensis,* Port Henry, N. Y., June 1866, leg. C. H. Peck (N. Y. St. Mus.) (*Type*).

165. *Pleospora Amelanchieris* Wehm., on *Amelanchier elliptica,* Hoback Canyon, Jackson, Wyo., July 16, 1940 (Wehm. Herb. 1141) (*Type*).

166. *Teichospora praestipa* Clem. inedit., on *Amelanchier orcophila,* Sulphur Springs, Colo., July 23, 1907 (Farl.: Clem. Crypt. Form. Colo. 456).

270. *Pleospora Thuemeniana* Sacc., on *Yucca* or *Agave,* Matamoras, Mexico, June 1895, leg. Dr. Egeling (N.Y.B.G.: Ellis coll.).

324. Undetermined, on *Calamagrostis,* Ad. Åre Jemtlandiae, June 27, 1930, leg. A. G. Eliasson (Riksmuseet: Fl. Suec.).

325. Undetermined, on *Elymus arenaria,* Suecia, litore inter Båstad et Malen, July 27, 1927, leg. A. G. Eliasson (Riksmuseet: Fl. Suec.).

329. Undetermined, on *Calamagrostis lanccolata,* Sueciae: prope viam inter Storlien et Storvallen Jemtlandiae, July 31, 1932, leg. A. G. Eliasson (Riksmuseet: Fl. Suec.).

332. Undetermined, on *Poa compressa,* Gottland: Bro, June 19, 1920, leg. T. Vestergren (Riksmuseet: Fung. Suec.).

335. *Pleospora tenuis* ined., on *Agrostis canina,* Gottland: Bro s;n, n,Bro, June 21, 1920, leg. T. Vestergren (Riksmuseet: Fung. Suec.).

339. Undetermined, on *Poa compressa,* Gottland: Bro, June 16, 1920, leg. T. Vestergren (Riksmuseet: Pl. Suec.).

352. *Pleospora papaveracea* (de Not.) Sacc., on *Papaver somniferum,* Syd. Myc. Germ. 791, Brandenburg bei Dammendorf bei Millrose, July 14, 1909, leg. P. Sydow (Riksmuseet).

421. *Pleospora coronata* Niessl, on *Carduus sphaerocephalus,* Italy: Conegliano, Aug., 1878 (La Plata Mus. 7185).

423. *Pleospora cereicola* Speg., on *Cereus quisco,* Batuco, Chile, Jan., 1909 (La Plata Mus. 2181) (*Type*).

424. *Pleospora Bardanae* Niessl, on *Althea rosae,* Italia: Conegliano, March, 1887 (La Plata Mus. 7183).

429. *Leptosphaeria aerea* Speg., on *Tillandsia bicolor,* Ensanada, La Plata, Argentina, Feb., 1881 (La Plata Mus. 2397) (*Type*).

438. *Pleospora Thuemeniana* Sacc., on *Yucca aloifolia,* Aiken, S. Carolina, Aest. 1876, leg. H. W. Ravenel (Riksmuseet: Thuem. Myc. Univ. 1846) (Farl.: Roum. Fung. sel. exs. 4850).

441. *Leptosphaeria obtusispora* Speg., on *Yucca gloriosa,* Flores, Buenos Aires, Argentina, March, 1881 (La Plata Mus. 2393) (*Type*).

447. Undetermined, on *Zizyphus jujuba,* Rohtak, India, May 18, 1945, leg. S. Ahmad (1218) (Wehm. Herb.).

449. *Pleospora relicina* (Fck.) on *Secale cereale,* Mahr-Weisskirchen, in ein Stoppelfelde, Feb. 29, 1912, leg. F. Petrak (Riksmuseet: Herb. Rehm).

450. *Pleospora relicina* Wint., on *Poa pratensis,* Mahr-Weisskirchen, Feb. 28, 1912, leg. F. Petrak (Riksmuseet: Herb. Rehm).

451. *Pleospora culmorum* (Cke.) Sacc., on *Triticum repens,* Stockholm: Djurgården May 8, 1914, leg. T. Vestergren (Riksmuseet: Micr. rar. sel.).

492. *Pleospora (diaporthoides),* on *Sueda fruticosa,* Ladhar, Shaikhupura, India, Aug. 16, 1945, leg. S. Ahmad (1415) (Wehm. Herb.).

EXPLANATION OF FIGURES

Representative spores of each respective collection were chosen and drawn by camera lucida, to scale, as indicated, in order to show variation and allow comparison.

FIG. 1. Spores of *Pleospora trichostoma* (Fr.) Ces. & de Not., from collection *450*. FIG. 2. Spores of *Pleospora mollis* Starb., from collection *35*. FIG. 3. Spores of *Pleosphaeria hyphasmatis* (E. & E.) Berl., from collection *1*. FIG. 4. Spores of *Pyrenophora delicatula* Vestergr., from collections *2* (*a*) and *60* (*b*). FIG. 5. Spores of *Pleospora calvescens* (Fr.) Tul., from collections *4* (*a*) and *5* (*b*). FIG. 6. *Pleospora pellita* (Fr.) Rab., from collections *10* (*a*), *424* (*b*), *14* (*c*), *120a* (*d*). FIG. 7. Spores of *Pleospora findens* E. & E., from collection *31*. FIG. 8. Spores of *Pleospora vagans* Niessl, from collections *24* (*a*), *25* (*b*), *23* (*c*), *32* (*d*), *34* (*e*), and *324* (*f*). FIG. 9. Spores of *Pleospora oligostachyae* E. & E., from collections *8* (*a*), *61a* (*b*), and *17* (*c*). FIG. 10. Spores of *Pleospora diaporthoides* E. & E., from collections *6* (*a*), *15* (*b*), *429* (*c*), and *423* (*d*). FIG. 11. Spores of *Pleospora diaporthoides*, from collections *447* (*a*) and *492* (*b*). FIG. 12. Spores of *Pleospora Boldoae* Speg., from collection *22*. FIG. 13. Spores of *Pleospora lactucicola* E. & E., from collections *16* (*a*) and *52* (*b*). FIG. 14. Spores of *Pleospora clypeata*, from collection *21*. FIG. 15. Spores of *Pleospora atromaculans* Rehm, from collection *18*. FIG. 16. Spores of *Pleospora Shepherdiae* Pk., from collections *164* (*a*), *19* (*b*), and *20* (*c*). FIG. 17. Spores of *Pleospora Amelanchieris* Wehm., from collection *166*.

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NOTES AND BRIEF ARTICLES

SOME COPROPHILOUS ASCOMYCETES FROM PANAMA [1]

SAMUEL L. MEYER AND VESTA GREEN MEYER

In 1944–45, the senior author was on duty at the Army School of Malariology in the Panama Canal Zone for about sixteen months. Field work in connection with the teaching and research activities of the School provided an opportunity to collect dung at various localities in the Canal Zone and the Republic of Panama.

The dung was collected in the field, dried, packeted, and shipped to The University of Tennessee. Permission for such material to enter the United States was granted by officials of the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture.

When the senior author returned to The University of Tennessee in 1946, a taxonomic investigation of the coprophilous Ascomycetes of Panama was begun. The species reported here constitute the first published contribution in that study.

The dried samples of dung were moistened with distilled water and placed on moist paper toweling in glass culture dishes of various sizes and depths, depending upon the size of the sample. Water was added as needed to keep the dung moist. Examination of each sample for coprophilous Ascomycetes was made at intervals over a period of four to five months when the substrata were burned. Dried specimens of all species included in the list have been placed in the herbarium of The University of Tennessee.

For the convenience of those interested, this report follows a taxonomic arrangement. The distribution data for some species may be incomplete; however, the general distribution pattern for each species is fairly accurately defined. Nomenclature of the Discomycetes is according to Seaver (**1942**); that for the Pyrenomycetes is according to Cain (**1934**).

[1] Contributions from the Botanical Laboratory, The University of Tennessee, N. Ser. No. 111.

The species listed may be grouped into some interesting categories:

1. Species new to Panama: So far as the writer is aware, none of the species listed here has been reported previously from the Panama Canal Zone or the Republic of Panama.

2. Species of widespread occurrence in the United States but apparently new to the Caribbean region: *Chaetomium bostrychodes* Zopf, *Sordaria decipiens* Winter, *S. vestita* Zopf, *Pleurage collapsa* Griff., *Sporormia minima* Auersw., *S. herculea* Ell. & Ev.

3. Species reported with a northern distribution in the United States but new to the Caribbean region: *Chaetomium spirochaete* Palliser.

4. Species reported from the United States and Bermuda but new to the Caribbean region: *Ascobolus immersus* Pers.

5. Species involved in a noteworthy extension of geographical range: *Ascodesmis microscopica* Seaver, *Sordaria appendiculata* Auersw., *Delitschia Marchalii* Berl. & Vogl.

6. Species reported on substrates other than those previously recorded: *Ascodesmis porcina* Seaver, *Chaetomium bostrychodes* Zopf, *C. spirochaete* Palliser.

DISCOMYCETES

Ascodesmis microscopica Seaver. No. 17908, on horse dung, Salud, Republic of Panama, April 5, 1945. Seaver (**1928**: 80) reports the distribution: New York; also in Europe.

Ascodesmis porcina Seaver. No. 17907, on horse dung, La Mesa, Republic of Panama, April 1, 1945; 17909, on horse dung, El Valle, Republic of Panama, April 1, 1945. Seaver (**1928**: 80) records the substrate and distribution: grown in the laboratories of The New York Botanical Garden on pig dung from Porto Rico. Horse dung appears to be a new substrate for this species.

Ascobolus immersus Pers. No. 17904, on cow dung, Chilibre, Republic of Panama, March 28, 1945; 17905, on horse dung, El Valle, Republic of Panama, April 1, 1945; 17906, on horse dung, Salud, Republic of Panama, April 5, 1945. Seaver (**1928**: 83) gives the distribution: New York to Colorado and Bermuda, probably throughout North America; also in Europe. This spe-

cies has also been collected in Quebec (Mains, Overholts, and Pomerleau, **1939**: 730), Virginia (Betts and Meyer, **1940**; Meyer, **1943**: 327; Wilson, **1947**: 375), and Tennessee (Meyer, **1941**: 402).

Saccobolus Kerverni (Crouan) Boud. No. 17844, on horse dung, Limon, Canal Zone, March 5, 1945; 17845 and 17847, on cow dung, 17846, on horse dung, Juan Mina, Canal Zone, March 11, 1945; 17848, on horse dung, Buenos Aires, Republic of Panama, March 22, 1945; 17849, on horse dung, and 17850, on goat dung, Santa Rosa, Republic of Panama, March 24, 1945; 17851, on horse dung, and 17852, on cow dung, Chilibre, Republic of Panama, March 28, 1945; 17853, on horse dung, La Mesa, Republic of Panama, April 1, 1945; 17854, on horse dung, El Valle, Republic of Panama, April 1, 1945; 17855, on cow dung, Las Uvas, Republic of Panama, April 1, 1945; 17856 and 17857, on cow dung, Lagarto, Republic of Panama, April 5, 1945; 17860, on cow dung, Lagarto, April 6, 1945; 17858, on cow dung, and 17859, on horse dung, Salud, Republic of Panama, April 5, 1945. Seaver (**1928**: 93) records the range of this species from New York to Colorado, Bermuda, and Porto Rico, probably common throughout North America; also in Europe. Seaver (**1942**: 308) notes a range extension to Quebec. This species has also been found in Florida (West, **1941**: 40), Tennessee (Meyer, **1941**: 403), and Virginia (Betts and Meyer, **1940**; Meyer, **1943**: 327; Wilson, **1947**: 375).

Ascophanus argenteus (Curr.) Boud. No. 17910, on cow dung, Lagarto, Republic of Panama, April 5, 1945. Seaver (**1928**: 115) lists the distribution: New York to Colorado and Porto Rico; also in Europe. The range has been extended to Michigan (Seaver, **1942**: 310) and Virginia (Wilson, **1947**: 375).

Ascophanus carneus (Pers.) Boud. No. 17911, on cow dung, Chorrera, Republic of Panama, March 6, 1945; 17912, on cow dung, Port of Chorrera, Republic of Panama, March 13, 1945; 17913, on horse dung, Juan Mina, Canal Zone, March 11, 1945; 17914, on cow dung, Las Uvas, Republic of Panama, April 1, 1945. Seaver (**1928**: 116) gives the distribution: New York to North Dakota, Florida, Colorado, Bermuda, and Porto Rico; also in Europe. A collection was made on the Mycological Society

Foray in Quebec (Mains, Overholts, and Pomerleau, **1939**: 730) and the species has been found in Tennessee (Meyer, **1941**: 403). Seaver (**1942**: 310) reports the range to Colombia, Venezuela, and Ontario.

Ascophanus granulatus (Bull.) Speg. No. 17875, on horse dung, El Valle, Republic of Panama, April 1, 1945. Determination by F. J. Seaver. Seaver (**1928**: 117) records the distribution: Connecticut to Iowa, South Carolina, and Mexico; also in Europe. The known range has been extended to include Winnepeg, California, Porto Rico, Dominican Republic, Venezuela, and Bermuda (Seaver, **1942**: 310).

PYRENOMYCETES

Sordaria fimicola (Rob.) Ces. & De Not. No. 17821, on horse dung, Chorrera, Republic of Panama, March 6, 1945; 17822, on horse dung, Chorrera, Republic of Panama, March 12, 1945; 17823, on horse dung, Port of Chorrera, Republic of Panama, March 13, 1945; 17824, on horse dung, Buenos Aires, Republic of Panama, March 22, 1945; 17825, on horse dung, Chilibre, Republic of Panama, March 28, 1945; 17826, on horse dung, Las Uvas, Republic of Panama, April 1, 1945; 17882, on horse dung, El Valle, Republic of Panama, April 1, 1945. Griffiths and Seaver (**1910**: 67) record this species from Vermont to Oregon, Arizona, and Alabama; also in Europe. They place it in the genus *Fimetaria* Griffiths and Seaver. It has been collected since in St. Croix, Virgin Islands (Seaver, **1925**: 5), Michigan (Ames, **1930**: 319), Ontario (Cain, **1934**: 18), and Virginia (Betts and Meyer, **1940**; Meyer, **1943**: 330; Wilson, **1947**: 376).

Sordaria appendiculata Auersw. No. 17887, on horse dung, Chorrera, Republic of Panama, March 12, 1945; 17888, on horse dung, Chorrera, Republic of Panama, March 6, 1945; 17889, on horse dung, Las Uvas, Republic of Panama, April 1, 1945. This species is listed as *Pleurage superior* D. Griff. by Griffiths and Seaver (**1910**: 74) and reported from Montana. It has also been found in Ontario (Cain, **1934**: 35).

Sordaria decipiens Winter. No. 17890, on horse dung, Las Uvas, Republic of Panama, April 1, 1945; 17891, on horse dung, Chorrera, Republic of Panama, March 12, 1945. Listed as

Pleurage decipiens (Wint.) Kuntze by Griffiths and Seaver (**1910**: 77) who give the range: Vermont to Montana, Arizona, and Alabama; also in Europe. It has been collected in Michigan (Ames, **1930**: 319), Ontario (Cain, **1934**: 44), and Virginia (Meyer, **1943**: 331; Wilson, **1947**: 376).

Sordaria vestita Zopf. No. 17836, on cow dung, Port of Chorrera, Republic of Panama, March 13, 1945; 17837, on horse dung, Santa Rosa, Republic of Panama, March 24, 1945; 17838, on horse dung, La Mesa, Republic of Panama, April 1, 1945; 17839, 17840, and 17841, on cow dung, Salud, Republic of Panama, April 5, 1945; 17843, on horse dung, Salud, Republic of Panama, April 6, 1945. The distribution is given as New York to Oregon, Arizona, and Louisiana and also in Europe by Griffiths and Seaver (**1910**: 76) who put the species in the genus *Pleurage* Fries. It is listed among the fungi collected on the Foray in Quebec (Mains, Overholts, and Pomerleau, **1939**: 731). This species has been found in Tennessee (Meyer, **1941**: 404), Ontario (Cain, **1934**: 45), and Virginia (Meyer, **1943**: 331; Wilson, **1947**: 376).

Pleurage collapsa Griff. No. 17835, on horse dung, El Valle, Republic of Panama, April 1, 1945. Griffiths and Seaver (**1910**: 80) place this species in the genus *Pleurage* Fries and record the distribution: New York to Alabama. The species has also been found in Saskatchewan (Cain, **1934**: 59) and Virginia (Wilson **1947**: 376).

Bombardia arachnoidea (Niessl) Cain. No. 17830, on cow dung, and 17831, on horse dung, Juan Mina, Canal Zone, March 11, 1945; 17832 and 17833, on cow dung, Las Uvas, Republic of Panama, April 1, 1945; 17834 and 17883, on cow dung, Lagarto, Republic of Panama, April 5, 1945; 17884 and 17885, on cow dung, Chilibre, Republic of Panama, March 28, 1945. Griffiths and Seaver (**1910**: 75) place this species in the genus *Pleurage* Fries and report the distribution: New York to New Jersey; also in Europe. It has been found in Porto Rico (Chardon, **1921**: 294–295), St. Thomas (Seaver, **1924**: 6), Ontario (Cain, **1934**: 73), Tennessee (Meyer, **1941**: 404), and Virginia (Meyer, **1943**: 330; Wilson, **1947**: 376).

Delitschia Marchalii Berl. & Vogl. No. 17879, on horse dung, Port of Chorrera, Republic of Panama, March 13, 1945; 17880,

on horse dung, La Mesa, Republic of Panama, April 1, 1945; 17881, on horse dung, Salud, Republic of Panama, April 5, 1945. Griffiths and Seaver (**1910**: 82) record the distribution: New Jersey; also in Europe. Griffiths and Seaver (**1910**: 82) list as the substrate: rabbit dung. Cain (**1934**: 80) records the species from Ontario with the observation that it is fairly common on the dung of various animals but especially rabbit.

Sporormia minima Auersw. No. 17865, on horse dung, Limon, Canal Zone, March 5, 1945; 17866, on horse dung, Chorrera, Republic of Panama, March 6, 1945; 17867, on cow dung, Chorrera, Republic of Panama, March 6, 1945; 17868, on horse dung, Chorrera, Republic of Panama, March 12, 1945; 17869, on cow dung, Port of Chorrera, Republic of Panama, March 13, 1945; 17870 and 17871, on horse dung, Santa Rosa, Republic of Panama, March 24, 1945; 17872, on cow dung, Chilibre, Republic of Panama, March 28, 1945; 17873 and 17874, on cow dung, Salud, Republic of Panama, April 5, 1945. Reported distribution: Vermont to Oregon, Arizona, and Louisiana; also in Europe (Griffiths and Seaver, **1910**: 94). It was collected in Ontario (Cain, **1934**: 94), in Quebec on the Mycological Society Foray (Mains, Overholts, and Pomerleau, **1939**: 731), and in Virginia (Meyer, **1943**: 331; Wilson, **1947**: 377).

Sporormia herculea Ell. & Ev. No. 17864, on horse dung, Santa Rosa, Republic of Panama, March 24, 1945. Griffiths and Seaver (**1910**: 88) record the distribution: Rhode Island to Texas. It has been reported from Ontario (Cain, **1934**: 110) and Virginia (Wilson, **1947**: 377).

Chaetomium bostrychodes Zopf. No. 17815, on cow dung, Salud, Republic of Panama, April 6, 1945; 17816, on rabbit dung, and 17817, on horse dung, Chilibre, Republic of Panama, March 28, 1945; 17818, on horse dung, Port of Chorrera, Republic of Panama, March 13, 1945; 17819, on horse dung, Buenos Aires, Republic of Panama, March 22, 1945. Reported range: New York to Louisiana; also in Europe (Palliser, **1910**: 62). This species has also been found in Iowa on open pasture land, one to three inches below the soil surface (Paine, **1927**: 254). It has been collected in Tennessee (Meyer, **1941**: 403) and Virginia (Meyer, **1943**: 330; Wilson, **1947**: 375). Palliser (**1910**: 62)

lists the following substrata: dog dung, sheep dung, old shoe, potatoes, and decaying portions of animals. Meyer (**1943**: 330) and Wilson (**1947**: 375) found this species on deer mouse dung while Wilson (**1947**: 375) also collected it from horse dung. Apparently, it had not previously been found on cow and rabbit dung.

Chaetomium spirochaete Palliser. No. 17820, on goat dung, Santa Rosa, Republic of Panama, March 24, 1945. Reported range: New Jersey to Iowa (Palliser, **1910**: 61). This species has been found growing on moist decayed paper and cotton root in a moist chamber but apparently has not been previously reported from dung.

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